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The U. K. Experience on the Effects of Off-Shore Sand and Gravel Extraction on Coastal Erosion and the Fishing Industry

by

R. Warren Drinnan and Douglas G. Bliss
Dobrocky Seatech Limited
Suite 48, 1000 Windmill Road
Dartmouth, NS
B3B 1L7

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Report

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Prepared under Canada-Nova Scotia
Mineral Development Agreement

SUMMARY AND RECOMMENDATIONS

A review of the issues related to coastal erosion and conflicts with the fishing industry resulting from marine sand and gravel extraction was carried out in the United Kingdom. The study also reviewed the management and regulatory procedures for administering the marine sand and gravel industry.

A number of the concerns expressed in the U.K. could potentially develop in Canada should marine mining increase from present levels. These issues were grouped into the following four categories:

1. Coastal Erosion

a) changes in wave refraction;
b) removal of protective bars;
c) changes in sediment transport patterns; and,
d) changes in residual sediment types.

2. Impact on Fishing Operations

a) marine disposal of debris, especially screens;
b) vessels operating outside of the terms of their licence;
c) vessels arriving unannounced and interfering with fishing operations;
d) permanent or temporary displacement of local fishing industry by extraction operations.

3. Fisheries Resource, Habitat and Other Environmental Concerns

a) potential destruction of spawning grounds and/or critical fish habitat;
b) alteration of the seabed to the detriment of subsequent recruitment of benthic organisms and fish species;
c) avoidance of sediment plumes by migrating species.

4. Administration and Management

a) lack of communication and information exchange between sand and gravel and fishing industries;
b) lack of procedures for the fishing industry to have direct input into the regulatory review process;
c) lack of basic information on both surficial geology and the biological and fishery resources.

The report concludes that a lack of communication between the fishing industry and the sand and gravel industry in the U.K. was a primary cause of many of the issues and recommends a number of procedures in Canada to improve the information exchange between the two groups. Another major issue in the U.K. was the need for information on the biological and geological resources. A similar lack of information exists in Canada and suggestions to improve this situation are included.

Recommendations to conduct marine aggregate extraction activities in Canada are listed below.

1. Applications to undertake activities that may have an impact on the fishing industry should allow for input from the fishing industry and an exchange of information. If prospecting areas are issued on an exclusive basis, then industry would be less sensitive to the confidentiality of location, which would promote the exchange of information.

2. All sand and gravel extraction licence applications should be reviewed by appropriate coastal scientists to determine the potential for coastal erosion or damage to shoreline structures.

3. The review process for mining licence application should include opportunities for other interests, particularly those of the fishing industry, to present information directly, as well as being represented by government fisheries personnel. The process should also ensure an appeal mechanism.

4. Appropriate or relevant environmental information to be included with each application for a licence to remove sand and gravel should include summaries of current and wave information and fishing utilization records.

5. Direct lines of communication should be established between the dredging companies and the fishing industry, both at the licence application stage and during production. Notice of changes in location by a dredging vessel should be given in advance by a minimum of two days.

6. The final authority in issuing a licence should be at "arms length" from the setting or collection of royalties.

7. Methods should be developed to ensure compliance with the terms and conditions of the prospecting and production licence. This would include:

   a) accurate positioning systems and instrumentation which will record position, time and operational information (e.g., suction pumps) for subsequent inspection;
   b) identification marks on all parts, particularly screens, that could be jettisoned offshore, plus manifest forms recording the movement to and from the offshore of these parts.
   c) regular, but unannounced, inspection of cargos and records to ensure quantities taken are within the conditions of the licence.

8. Monitoring should be carried out periodically throughout the life of the production permit to record changes in surficial geology and bathymetry, to ensure that the bottom material remains similar to its original character.

9. If required, an objective compensation board should be established to expediently review compensation claims and make awards.

10. Information on the distribution of sand and gravel resources, particularly in the nearshore (out to the 30-metre contour), is urgently required to help managers identify alternative sources.

11. Environmental studies on the longer-term impacts of aggregate extraction should be carried out, particularly on the effects of substrate alteration on recolonization rates and species, and on the effects to a commercial fishery of extended dredging activities.

RESUME ET RECOMMENDATIONS

Une étude des questions liées à l'érosion des côtes et aux conflits avec l'industrie de la pêche découlant de l'extraction du sable et du gravier en mer a été effectuée au Royaume-Uni. L'étude porte également sur les méthodes de gestion et de réglementation de l'industrie marine du sable et du gravier.

Certaines questions qui préoccuppent le Royaume-Uni pourraient également poser des problèmes au Canada si l'exploitation minière en mer se développait davantage. Ces questions ont été regroupées en quatre catégories:

1. Erosion des côtes

a) changements de la réfraction de la houle;
b) enlèvement des barres de protection;
c) changements des modèles de transport des sédiments; et,
d) changements des types de sédiments résiduels.

2. Répercussions sur l'industrie de la pêche

a) élimination de débris en mer, particulièrement de cribles;
b) navires qui ne respectent pas les modalités de leur permis;
c) navires qui arrivent à l'improviste et nuisent aux activités de la pêche;
d) déplacement permanent ou temporaire de l'industrie locale de la pêche par l'exploitation minière.

3. Ressources de la pêche, habitat et autres questions environnementales

a) destruction possible des aires de frai ou de l'habitat des poissons ou des deux;
b) changement du fond marin et les conséquences sur la colonisation du milieu par les organismes banthiques et sur les espèces de poissons;
c) espèces migratrices qui évitent les panaches sédimentaires.

4. Administration et gestion

a) manque de communications et d'échanges d'information entre l'industrie de la pêche et celle du sable et du gravier;
b) manque de marches à suivre permettant à l'industrie de la pêche de participer directement au processus d'examen de la réglementation;
c) manque d'information de base sur la géologie des formations superficielles, sur les ressources biologiques et sur la pêche.

Le rapport conclut qu'un manque de communications entre l'industrie de la pêche et celle du sable et du gravier au Royaume-Uni a été la cause première de bon nombre de problèmes et recommande un certain nombre de marches à suivre pour le Canada afin d'améliorer l'échange d'information entre les deux groupes. Une autre question importante au Royaume-Uni a été le besoin d'information sur les ressources biologiques et géologiques. Le Canada manque lui aussi d'information dans ce domaine, et le rapport propose des moyens visant à améliorer cette situation.

Voici les recommandations relatives aux activités d'extraction des agrégats en mer au Canada:

1. Les demandes pour entreprendre des activités qui peuvent avoir des répercussions sur l'industrie de la pêche devraient prévoir la participation de l'industrie de la pêche et un échange d'information. Si les régions de prospection sont attribuées de façon exclusive, alors le caractère confidentiel de ces régions sera moins important pour l'industrie, ce qui devrait encourager l'échange d'information.

2. Toutes les demandes de permis pour l'extraction de sable et de gravier devraient être étudiées par des spécialistes du littoral compétents afin de déterminer les possibilités d'érosion des côtes ou de dommage aux structures du littoral.

3. Le processus d'examen des demandes de permis d'exploitation minière devrait prévoir la possibilité, pour d'autres intérêts, particulièrement ceux de l'industrie de la pêche, de présenter de l'information directement et de se faire représenter par des fonctionnaires de Pêches et Océans. Le processus devrait également veiller à ce qu'il y ait possibilité d'appel.

4. L'information pertinente relative à l'environnement qui doit être présentée avec chaque demande de permis d'extraction de sable et de gravier devrait comprendre des résumés de l'information sur les courants marins et la houle ainsi que des dossiers concernant la pêche.

5. Les sociétés de dragage et l'industrie de la pêche devraient être directement en communication à l'étape de la demande de permis et pendant la production. Un préavis d'au moins deux jours devrait être donné lorsqu'un navire de dragage change d'emplacement.

6. L'autorité finale qui délivre les permis doit être "sans lien de dépendance" en ce qui concerne l'établissement ou la perception des redevances.

7. Il faudrait mettre au point des méthodes pour garantir le respect des modalités des permis de prospection et de production, qui comprendraient:

   a) des systèmes précis de positionnement et des appareils pour enregistrer la position, l'heure et les données opérationnelles (par ex. les pompes aspirantes) aux fins d'inspection par la suite;
   b) des signes d'identification sur toutes les pièces, particulièrement sur les cribles, qui pourraient être jetées à la mer, ainsi que des manifestes où est inscrit le va-et-vient des pièces entre la terre et les installations en mer;
   c) l'inspection régulière, mais à l'improviste des cargaisons et des dossiers afin de veiller à ce que les quantités prises n'excèdent pas celles prévues par les modalités du permis.

8. Une surveillance devrait être exercée périodiquement au cours de la durée du permis de production afin de noter tout changement de la géologie des formations superficielles et de la bathymétrie pour faire en sorte que le fond marin demeure semblable à ce qu'il était avant l'exploitation minière.

9. Au besoin, il faudrait mettre sur pied une commission d'indemnisation objective pour étudier convenablement les demandes d'indemnisation et rendre des décisions.

10. Il y a un besoin urgent d'information relative à la distribution des ressources en sable et en gravier, particulièrement près des côtes (jusqu'à l'isobathe de 30 mètres), pour aider les gestionnaires à trouver d'autres sources.

11. Des études environnementales sur les incidences à long terme de l'extraction des agrégats devraient être faites, particulièrement sur les conséquences de la modification des substrats sur le rythme de recolonisation et sur les espèces sans oublier les effets des activités prolongées de dragage sur la pêche commerciale.

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LIST OF ACRONYMS

AES - Atmospheric Environment Service (Canada)

ASFA - Aquatic Sciences and Fisheries Abstracts

BACMI - British Aggregates and Construction Materials Industry

BCS - British Council of Shipping

BGS - British Geological Survey

CEC - Crown Estate Commissioners (U.K.)

COGLA - Canada Oil and Gas Lands Administration

DAFS - Department of Agriculture and Fisheries for Scotland

DFO - Department of Fisheries and Oceans (Canada)

DOD - Department of Defense (U.K.)

DOE - Department of Environment (U.K.)

DOT - Department of Transport (U.K.)

EIS - Environmental Impact Study

GEOREF - Geological Reference File

GPS - Global Positioning System

HR - Hydraulics Research Limited (U.K.)

ICES - International Council for Exploration of the Sea

MAFF - Ministry of Agriculture, Fisheries and Food (U.K.)

MEDS - Marine Environmental Data Service (Canada)

NCC - Nature Conservancy Council (U.K.)

NRC - National Research Council (Canada)

NTIS - National Technical Information Service

OMCRS - Ocean Mining Citation Retrieval System

SAGA - Sand and Gravel Association (U.K.)

SDA - Sea Defense Authority (U.K.)

SFC - Sea Fishery Committee (U.K.)

1.0 INTRODUCTION

1.1 GENERAL

Canada, with its lengthy coastline and large continental shelf area, has considerable potential for commercial development of offshore non-fuel minerals. Although early activities were aimed more at the deep seabed minerals such as manganese modules, recent interest has focused on shelf minerals such as sand and gravel and placer deposits (Pasho, 1985).

This report reviews the marine sand and gravel extraction industry in the United Kingdom and the concerns related to coastal erosion and conflicts with the fishing industry. The latter is of particular concern to the government of Canada, which will be taking an active role in promoting direct exchange and effective communication between the fishing and mining industries[1]. The study was a co-operative project with the Nova Scotia Department of Mines and Energy, and the Department of Energy, Mines and Resources, and supported by funding through the Canada - Nova Scotia Mineral Development Agreement. The material updates and provides more in-depth information to a previous report entitled "The United Kingdom Offshore Aggregate Industry. A Review of Management Practices and Issues" (Pasho, 1986).

The initial report gave an overview of the development of the offshore aggregate extraction industry from the early 1960's onwards and considered the structure and function of the regulatory agencies which are involved in the licencing procedure. Many of the issues and concerns were identified but were not closely examined.

The purpose of this study is to identify current concerns and practices related to sand and gravel extraction from the seafloor, particularly their effect on the fishing industry and on coastal erosion. Those issues which were applicable to Canada, have been examined and suggestions for mitigative measures are presented.

[1] Minister of State (Mines), Government of Canada; 16th Annual Underwater Institute, Halifax, Nova Scotia, Oct. 22, 1985.

This report deals primarily with aggregates (sand and gravel) which are low cost, bulk materials used in construction, and constitute virtually all of the marine mineral activity in the U.K. However, many of the issues which are identified are also applicable to mining other industrial minerals such as silica carbonate sand or placer deposits.

1.2 STUDY OUTLINE

The study was split into two distinct phases. The first phase was an extensive literature search of published information on the issues, environmental effects and management procedures related to marine dredging and mining. The primary database used was the Ocean Mining Citation, Retrieval System (OMCRS) of the Department of Energy, Mines and Resources, supplemented by NTIS, ASFA and GEOREF. The following key words were used:

United Kingdom - sand and gravel;
Dredging, environmental impact;
United Kingdom - dredging/mining - effects;
- impact;
- environment;
- regulations;
- legislation/law;
- erosion;
- fisheries.

Over 200 titles were generated from this computer search, out of which 49 were selected and reviewed. The majority of reports were related to British and Dutch studies, primarily because offshore aggregate extraction has been underway in both countries for many years. The most comprehensive reports on the identification of concerns were from the ICES Reports of the Working Group on Effects on Fisheries and Marine Sand and Gravel Extraction, which consisted of members from the United Kingdom, the Netherlands, Denmark, the Federal Republic of Germany, France, Sweden, Norway, Ireland, U.S.A., Finland and Belgium. This group published a series of reports during the 1970's which examined the impact of offshore dredging on fisheries (ICES, 1975, 1977, 1979). The committee was disbanded in 1981 but has recently reconvened under Dr. S.J. deGroot of the Netherlands Institute for Fishery Investigations with the initial meeting planned for May, 1986.

The second phase of the study consisted of interviews conducted in the United Kingdom with people from organizations which were involved with, or were affected by, offshore aggregate mining or the review process by which the industry is managed and regulated. The purpose of these interviews was to ensure that all concerns and issues were identified, to determine the advantages and problems associated with the present review and regulatory procedures in the U.K., and to obtain a clear understanding of all facets of marine aggregate mining. A list of organizations contacted is presented in Table 1.1.

The information presented in this report is a result of a thorough and critical analysis of each issue by the authors and by other professionals within industry and government who have had relevant experience. The diversity of interests represented by those interviewed made it inevitable that differences of opinion appeared. All issues are presented in this review. Those concerns in which there was a consensus of opinions or which was supported by a significant number of people interviewed and by published material were considered major issues.

Comments have been provided by: Nova Scotia Department of Mines and Energy; Nova Scotia Department of Fisheries; Department of Energy, Mines and Resources; Department of Fisheries and Oceans; Fishery Products International Ltd. and the Atlantic Fishing Vessel Association.

Table 1.1 Organizations Contacted with Respect to Offshore Dredging in the United Kingdom

Organization	Status
ENGLAND	
Crown Estate Commissioners (CEC) Foreshore and Seabed Branch	- trustee of offshore minerals - responsible for licences
Dept. of Environment (DOE) Minerals Division	- responsible to co-ordinate government view - contact other agencies
Ministry of Agriculture, Fisheries and Food (MAFF) Fisheries Inspectors Fisheries Laboratories	- determine impact on fishing, fish stocks, etc. - represent fishermen - conduct fisheries research
Hydraulics Research Limited (HR) Coastal Engineering Group	- determine if proposed dredging has impact on coastal erosion - report to CEC
Dept. of Transport (DOT) Marine Directorate	- determine if dredging operations affect navigation - report through DOE
Lewis & Duvivier Ltd.	- consultants to CEC
Alluvial Mining Co. Ltd.	- conduct prospecting and geophysical studies for dredging companies
ARC Marine	- dredging company
Civil and Marine Ltd.	- dredging company
British Dredging	- dredging company
BOS Kalis Westminster Ltd.	- dredging company
Sand and Gravel Association Marine Section	- represent dredging industry
Sea Sediments	- marine environmental consulting company
Sea Fisheries Committee	- represent fishermen through district representatives

Table 1.1 (cont'd)

Organization	Status
National Federation of Fishermen's Organization	- represent fishermen
Fishery Development Office Seafish Industry Authority	- represent fishermen
Shellfish Association of Great Britain	- represent fishermen
Lowestoft Inshore Fishermen's Association	- represent fishermen
Yorkshire and East Anglia Fish Producers Organization	- represent fishermen
SCOTLAND	
British Geological Survey Marine Earth Sciences	- mapping seabed resources
Dept. of Agriculture and Fisheries for Scotland Fisheries Inspector Marine Laboratory	- equivalent to MAFF in England
Scottish Office	- assist in co-ordinating industrial development
Heriott-Watt University Institute of Offshore Engineering	- marine research
Scottish Fishermen's Federation	- represent fishermen
HOLLAND	
Netherlands Institute for Fisheries Investigations	- fisheries research

2.0 DREDGING PRACTICE AND LIMITATIONS

2.1 DREDGERS

Dredging for marine sand and gravel is conducted from ships which are dedicated to this task. In the U.K., there are 53 ships of this type (see Appendix 1) which range in size from 45 m to 107 m in length and carry from 250 to 7500 tonnes of cargo. Of these ships, twenty are anchor dredgers and the remaining number are trailer suction dredgers. The principal dredging areas in the U.K. are in the North Sea in the Humber Estuary and East Anglia; the north outer Thames Estuary; the waters around the Isle of Wight; the Bristol Channel; and Liverpool Bay. At present, there are no licenced dredging areas off the coast of Scotland. A map of these areas is shown in Figure 2.1.

The two basic types of dredging are anchor dredging and trailer suction dredging. In anchor dredging, a ship anchors and extracts the surficial sediment through a forward-facing riser pipe. This type of extraction method creates pits on the seafloor, and in an intensively dredged area the seafloor may develop a moonlike appearance. The pits may be many metres deep, depending on the depth of the deposit and operating depth of the dredger.

Trailer suction dredging has the riser pipe trailing behind the ship as the vessel maneuvers along a pre-determined course. The ship moves between 1 and 3 km/hr (0.5 to 1.5 kts) and leaves furrows in the seafloor much like a ploughed field. Typical dimensions of these furrows are 0.5 to 4.0 m wide and 0.2 to 0.5 m deep. The depth of the furrows increases with successive passes of the dredger. Schematics of the two types of dredging are presented in Figure 2.2. A photograph of a typical trailer suction dredger is shown in Figure 2.3.

Other types of dredging, such as clam shell or continuous bucket dredging, are not used for aggregate deposits because they are not economical. These types of vessels generally reserved for coastal and harbour dredging.

Once the sand and gravel is sucked up through the draghead, it travels up the riser pipe and through the specially designed centrifugal pumps located in the hull of the ship. The material is pumped up through towers on the deck of the ship where screening takes place and the finer or coarser material, as the case may be, is selected and dumped into the cargo hold. The hold is initially filled with sea water which is displaced as the vessel gradually fills with sand and gravel. The cargo is unloaded by buckets; the more modern dredgers use dragger buckets which discharge onto a conveyor belt, which then unloads on the wharf. The more modern dredgers also have the capacity to dump the cargo below the vessel. A series of photographs depicting the process on the M.V. Cambrae is shown in Figures 2.4 to 2.7.

Maximum operating depth for the suction dredgers is approximately 35 m. Beyond this depth, pumps or eductors must be installed in the draghead or riser pipe to assist in the lift of the material. Centrifugal pumps are used because they have the greatest suction lift capacity. These pumps are installed very low in the ship below the waterline to minimize the suction lift distance from the pump to the draghead. The potential suction lift of a particular pump is called the net positive suction head (NPSH). This parameter is dependent upon the density of the sand/gravel/water mixture, the atmospheric pressure, the vapour pressure of the water, the losses in the pipe system due to friction and the velocity of the mixture through the pipes and pump. The pump characteristics are limited by the velocity of flow which must be maintained to keep the solids in suspension and the volume required to fill a cargo hold in an economical period of time. All of these factors contribute to the depth limitation of about 35 m.

Figure 2.1 Areas around the U.K. where sand and gravel extraction is licenced.

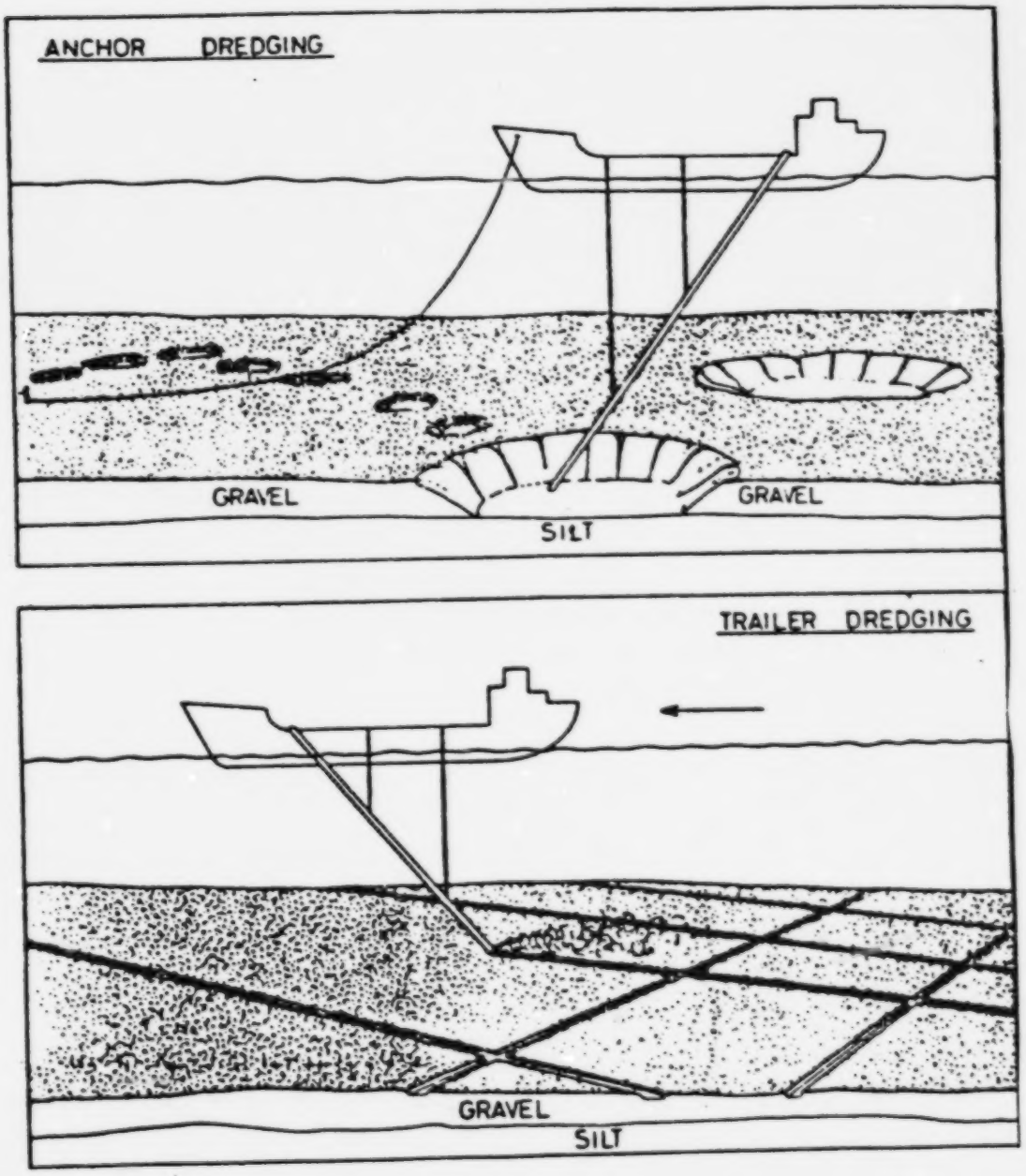

Figure 2.2 Schematic of the effect of the seabed from anchor and trailer suction dredging.

Figure 2.3 Typical trailer suction dredger steaming out of the Thames Estuary.

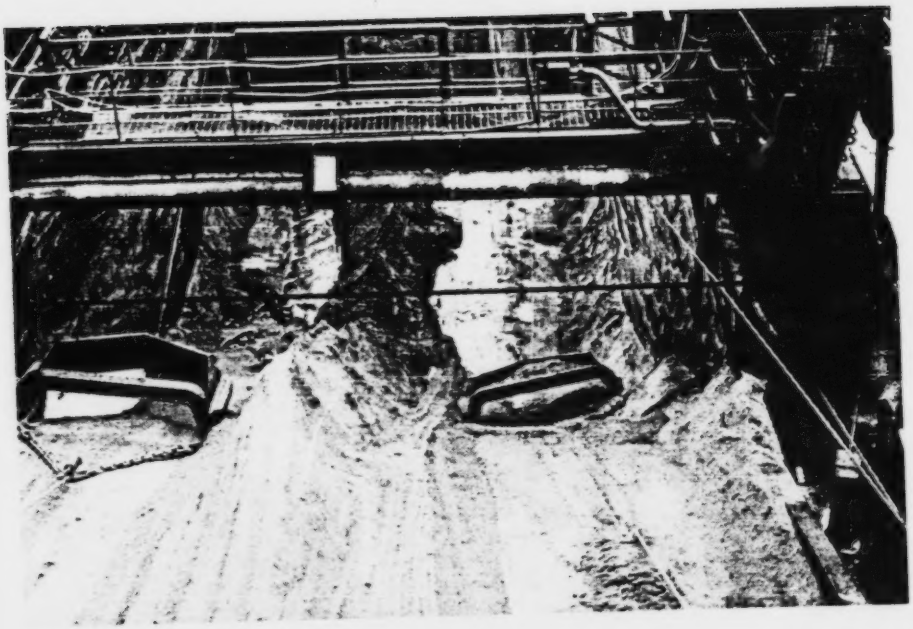

Figure 2.4 Drag buckets used to unload sand onto conveyor belts which discharge the cargo onto the wharf.

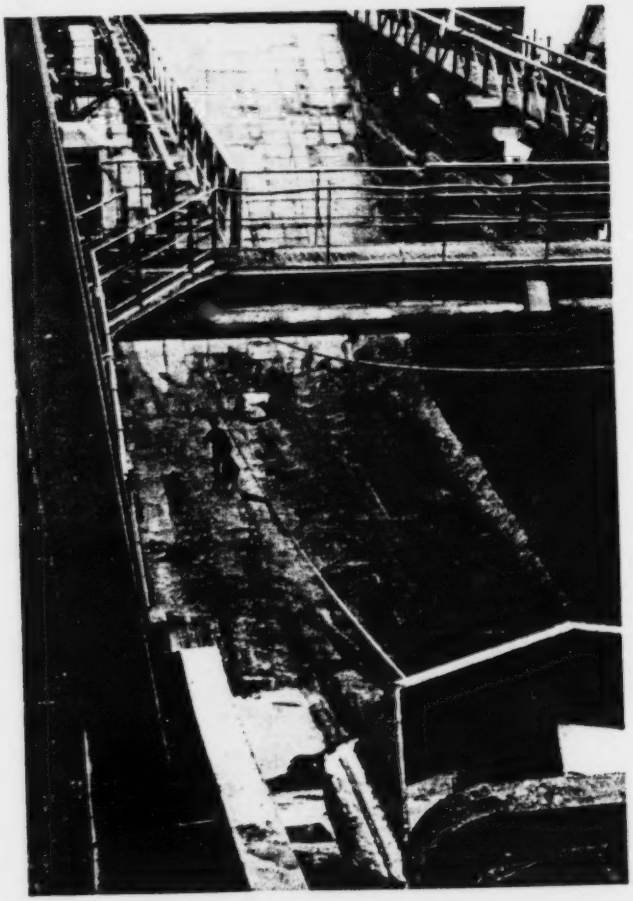

Figure 2.5 Empty hold of the M.V. Cambrae after unloading 5,000 tonnes of sand at a wharf on the Thames Estuary.

Figure 2.6 Night operations discharging the aggregate/water mixture into the hold of the dredger.

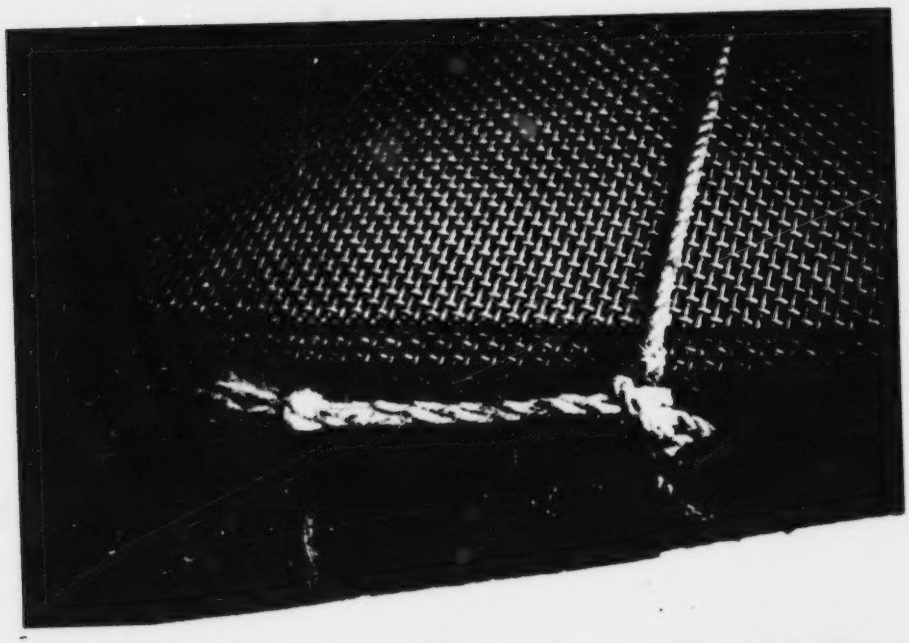

Figure 2.7 Standard screens used to sort the fines out of the sediment. Screens have 9.5 mm (3/8 inch) openings.

2.2 DREDGING METHODOLOGY IN THE U.K.

The basic commercial philosophy while dredging for marine aggregates is to maintain a quick and efficient operation. Marine aggregate is a low cost, bulk material with a low profit margin. In order to generate a profit, as much material as possible must be sold on the open market. To achieve this, the dredgers in the U.K. attempt to operate on a 24-hour cycle. This is done to keep the buyer supplied with a constant source of aggregate and to fit in with the tidal cycles if there are depth limitations at wharves.

The radius of operation for the dredgers is about 180 km (100 nm) from the market (wharf). A typical 24-hour cycle on a modern dredger with self-discharging capability would consist of a nine-hour steam to the extraction site, three hours to load the hold, a nine-hour steam back and three hours to unload the cargo. This cycle is maintained throughout the year except when the ship goes through annual maintenance.

Market demands for sand and gravel are never constant and the dredgers must be flexible enough to respond to changing demand. For example, a dredger may be working a gravel deposit but have a requirement to provide within a few days some sand fill for a land reclamation scheme. To satisfy these demands, the dredger needs access to a licenced area where the desired sand is located. The dredger may only go to this area for one or two loads and then return to the gravel deposit to carry on its previous operations. For this reason, dredging companies frequently have more than one licenced area. Some of these areas may not be regularly worked and so for much of the time, they are open to other interests such as fishing.

Recently, two new vessels have been ordered by a dredging company. These dredgers are capable of operating in depths of 50 to 60 metres, which will allow them to carry out operations further offshore than is presently possible with the existing fleet.

3.0 MANAGEMENT AND ADMINISTRATIVE PRACTICE IN THE U.K.

3.1 GENERAL

The regulatory process is based on a "two-tier" system for the two and distinct phases of marine aggregate mining - prospecting and extraction (production). An application for a prospecting licence can have, but is not generally given, a "government view" review as the potential impacts from prospecting are much smaller than for extraction. The review of an extraction licence application is much more rigorous and an official "government view" is formulated after consultation with any agencies or organizations which may be affected by the extraction of sea floor deposits.

The Crown Estate Commissioners (CEC), as the agency which acts as the trustee of all Crown lands held in trust by the British Parliament, is responsible for maintaining, enhancing and managing all Crown lands. The CEC manages the rights to exploit minerals (other than hydrocarbons and coal which are managed by the Department of Energy) in territorial waters within the 3 nm limit and on the U.K. continental shelf. Their authority is derived from the Crown Estate Act, 1961 and the Continental Shelf Act, 1964.

The CEC is responsible only to the Exchequer, and is not under the authority of any government ministry. The CEC manages the lands of the seabed and foreshore below the higher high water mark and up to the limit of tidal influence in rivers and estuaries. Beyond the tidal influence the rights to the lands and rivers are controlled by the Department of Environment (DOE). There are some areas of the foreshore and seabed which are not under the control of the CEC as the rights have been deeded to other owners in times past. These areas, however, are small and confined to harbours, rivers and estuaries.

The CEC is the final authority in the regulatory process and is responsible for granting licences and acting as the arbitrator between the dredging industry and all other organizations (primarily government). A flowchart showing the organization of the consultation process for licence approval is shown in Figure 3.1.

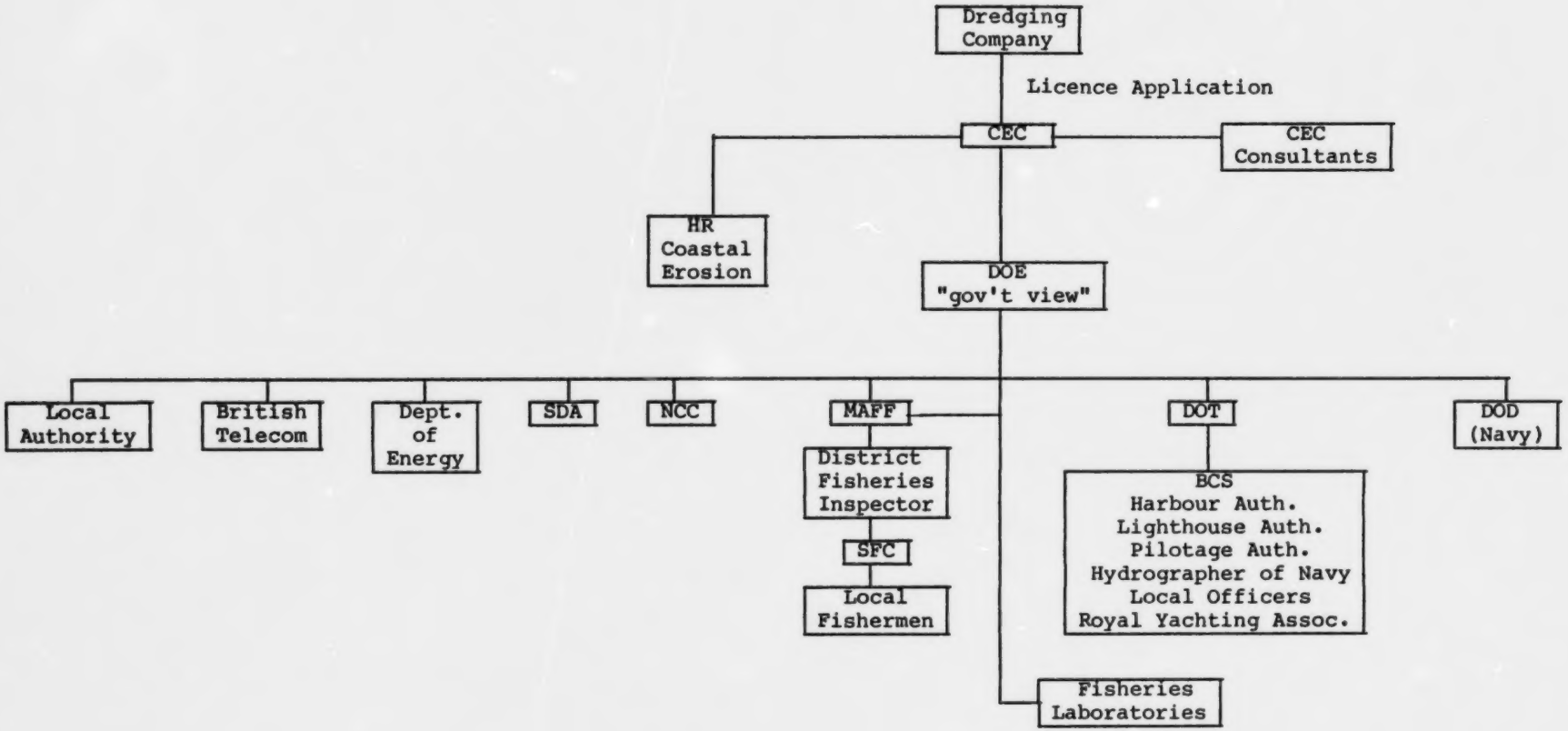

Figure 3.1 Flowchart showing the formal consultation procedure for extraction licence applications in England and Wales (the organization is the same in Scotland but the agencies have different names).

Hydraulics Research Ltd. (HR) is consulted by CEC to formulate an opinion on whether coastal erosion is a potential problem with the proposed licence. This is separate from the government consultive process. A favourable opinion must be received from HR before an application is allowed to proceed through the government view process.

The Minerals Division of the Department of Environment (DOE) is responsible for co-ordinating the government view. In this capacity, they consult all government departments whose interest might be affected by the extraction. Any objections which might be raised are considered by DOE and if the objection is serious enough, an "unfavourable" government view is given to the CEC. This will stop the application. If a "favourable" view is given then the application is generally approved.

Organizations which are consulted by DOE to formulate the government view include:

Ministry of Agriculture, Fisheries and Food (fisheries concerns)
Department of Defense (naval exercise areas, etc.)
Department of Transport (navigation and harbours)
Department of Energy (oil and gas pipelines)
British Telecom (telecommunications and power cables)
Coast Protection and Sea Defense Authorities
Nature Conservancy Councils (areas of marine sensitivity)
Local Authorities (Borough/District Councils, Regional Water Authority, etc.)

The Ministry of Agriculture, Fisheries and Food (MAFF), is the most important player in the government view process. They are responsible for managing the fishery, including maintaining adequate habitat quality, as well as representing the fishing industry and their concerns. MAFF consults the local fishermen through District Fisheries Inspectors and Sea Fisheries Committees. The Fisheries Laboratories will be consulted about areas of important fishing or spawning grounds and for information on the potential detrimental effects on fishing stocks from aggregate extraction.

In forming the government view, the various government departments may have differing opinions. If a compromise cannot be formulated, then the government view opinion is decided at the ministerial level between the ministers of the departments in conflict.

In formulating the government view, there can be considerable informal discussions between MAFF, DOE, CEC and the dredging companies to come to a compromise with which all parties are satisfied. The desire to come to an acceptable compromise is encouraged as it is official government policy to encourage the exploitation of marine aggregates (DOE Circular 21/82).

3.2 PROSPECTING LICENCE

Prospecting licences are issued by the CEC for a period of (generally) two years, but can be up to four years long. The cost for one of these licences is equivalent to about $1,000.00[1]. The areas covered by a prospecting licence can be quite large, up to 1,350 km^2 (400 nm^2). The rights for prospecting in an area are not exclusive, so more than one company may be prospecting in the same area.

A prospecting licence will not be granted in areas where there are existing production licences, pipelines or cables or other predetermined exclusive areas such as munitions dumping grounds.

A dredging company wishing to prospect in a certain area will generally conduct a desk study from information available from the British Geological Survey. The information is in the form of geological maps, which present seabed sediment distribution over parts of the continental shelf. The maps can be used to locate general areas where there may be sand or gravel deposits. A dredging company may also consult with geophysical firms which have had experience prospecting and doing other studies offshore.

[1] All values have been converted to 1986 Canadian dollars.

Once a dredging company determines the area in which they wish to prospect, they submit an application to the CEC. The application will include the co-ordinates of the desired area.

The CEC must inform MAFF, through DOE, of the prospecting co-ordinates. At this stage the review is internal only, and no outside parties are consulted. The reason for having an internal review is to maintain the confidentiality of the plans of the dredging company and any prospecting information which it collects. If MAFF feels that there would be an objection to dredging in a portion of the proposed area, it will inform the operators of potential problems or objections should there be an application for an extraction licence.

With the prospecting licence, a dredging company is allowed to use bulk sampling as a prospecting method and can take up to 1,000 tonnes of material from the seabed (this is equivalent to about 60 dumptruck loads). Before a bulk sample is taken, the dredging company must inform the CEC of their intention at least two weeks beforehand. The CEC must give its approval before the bulk sampling may proceed and consults with MAFF for objections. In this case, MAFF will often formulate a "mini-government view" and obtain the opinions of the fishermen through the Sea Fisheries Committees for any possible objections. Generally this is a straight forward process and the approval can be given in the two week time span.

In practice, the CEC will also contact the Department of Transport for any navigation concerns, and its own consultants or HR for possible coastal erosion problems. Generally, a prospecting application takes about one month to process.

Because objections, if raised, are generally from fishermen, the CEC, DOE and MAFF are encouraging direct informal consultations between the dredging industry and fishermen. It has been found that the time taken for the formal consultation process is reduced when informal discussions and compromise to initial objections have taken place.

The review process follows the "users pay" philosophy with respect to the extraction of resources. The cost of prospecting is borne by the company involved. Data collected on the surficial geology of the seabed during prospecting are surrendered to the CEC. The information is considered proprietary but it is also submitted to the BGS, who incorporate it into their own data base for preparation of the surficial geology charts of the seafloor.

Scotland has the same process for a prospecting application but the Scottish equivalent of MAFF is called the Department of Agriculture and Fisheries for Scotland (DAFS). In Scotland, informal consultation between representatives of the fishing industry, the dredging company and government officials are encouraged even at the prospecting stage.

3.3 EXTRACTION LICENCE

The process to obtain an extraction licence is a more formal, thorough consultation procedure which includes all the organizations shown in Figure 3.1. It is at this point that major and minor objections are examined. Depending on the nature of the concerns, it can take between two months to two or more years to process an extraction licence application.

An application for a production licence is considered only if the applicant has first held a prospecting licence covering the area in question and has a proven capability in ships, equipment and experience to extract the material from the seafloor. The application must also contain the prospecting results and the co-ordinates for the desired production area.

After the CEC has received an application, the primary consideration is to determine if any potential coastal erosion effects exist from the proposed production. If there are objections, then the licence application proceeds no further. The CEC sends the application to Hydraulics Research Ltd. (HR) at Wallingford to form a view on possible coastal erosion problems. In practice, the coastal engineering consultants retained by the CEC review the application first and will reject any that obviously do not meet the criteria before sending the application to HR.

3.3.1 Coastal Erosion Review Process

The Coastal Engineering Group at Hydraulics Research Ltd. is responsible for forming a favourable or unfavourable view of the application. There are four basic criteria which every application must meet. The four criteria of acceptance are as follows:

a) No significant change(s) in the wave refraction/diffraction patterns which may change the shoreline wave climate leading to erosion or accretion;
b) Offshore bars or banks that provide coastal protection against wave attack cannot be removed;
c) The extraction must occur far enough offshore that the onshore/offshore sediment transport regime is not affected; and,
d) No beach drawdown can occur due to beach material falling into dredged holes or trenches.

Depending upon the situation, the view formed by HR goes through a series of steps (e.g., literature review, site visit, computer model results or construction of a physical model or site-specific research study). Each of these steps provides more detailed information about an area and, of course, is more expensive. The applicant is responsible to pay for any studies conducted by HR and before HR proceeds, they will give a quote on the cost. If an applicant does not want to pay, the application process is stopped. A desk study for an initial assessment of an area generally costs between $1,000 to $4,000 CDN.

The steps to form the coastal erosion view are explained below. They are listed in sequence of increasing complexity (and cost). Depending on the degree of concern and available information, HR may present its view after any one of the following steps:

a) Desk Study: This entails the preliminary examination of potential problems. Generally, if the area is outside the 18 m "stopline" (see Section 4.2) there is rarely an objection. If the area is inside the

"stopline", then any available information on the hydrodynamic, meteorological and coastal conditions will be examined to determine potential problems.

b) Wave Refraction/Diffraction Study: Numerical computer modelling of the area is done to determine if the refraction/diffraction patterns could be significantly altered due to aggregate extraction. If so, further studies may be required or licence application may be rejected.

c) Physical Models and/or Field Studies: If there is a lot of controversy concerning an application, these studies may be done. Physical models give semi-quantitative results on the actual erosional process but can be difficult to interpret due to scale effects, particularly of large-area sediment transport problems. They provide a visual demonstration of the processes at work. Field studies measure actual conditions at a site and yield the most important data on processes which, in turn, provide calibration baselines for more accurate computer simulations. These studies are rarely done because of the expense. However, the government may provide financial assistance if it believes the information will be useful in other applications, or to resolve particularly important objections.

d) Discharge Plume and Sedimentation Models: These numerical models give information on the fate of discharge plumes and on sedimentation rates on the seafloor, but have only recently been applied to the sedimentation concerns. It is not known whether these models will become standard procedure in reviewing applications.

After conducting one or more of the study steps and comparing the proposed application with the four basic criteria, HR gives an unfavourable or a favourable view.

If an unfavourable view is given, the CEC will then reject the application. If a favourable view is given there will frequently be limiting conditions attached to the application. The CEC then passes the application with the limitations or comments from HR, to DOE to form the "government view".

If coastal erosion did occur, resulting in property damage, after HR had given a favourable view on proposal dredging, then HR could possibly be held liable for damages, but only if negligence were proven by a client who consequently suffered losses (pers. comm. T. Chadwick, HR).

3.3.2 Government View Review Process

After an application comes back from HR it goes to the Minerals Division of the Department of Environment, who are responsible for co-ordinating the "government view". As the co-ordinator, DOE contacts all government departments whose interest may be affected by the extraction. This is a formal process and it is at this point that organizations or government departments may state objections to the application.

The most important department to be consulted in this process is the Ministry of Agriculture, Fisheries and Food (MAFF), which is responsible for managing fisheries resources; they also act as a representative for the fishing industry. The majority of objections have involved fisheries issues as it is this industry which can be in direct conflict with the aggregate industry.

The Fisheries Laboratories at Lowestoft and at Burnham-on-Couch in England, or the Marine Laboratory in Aberdeen, Scotland, are consulted for an opinion on possible detrimental effects due to dredging. They are responsible for obtaining fisheries information through scientific studies and evaluation. Because of the dynamic nature of fisheries stocks, it is a difficult task to know the locations of spawning grounds and habitats. Generally, the information available on impacts on fisheries resources is limited, so that MAFF tends to give conservative judgements when analyzing dredging impacts. MAFF will also use their own data on fisheries stocks, catch statistics and catch projections, to gauge the impact that dredging may have. In general however, if an area is known as a spawning ground, particularly for herring, MAFF will not give a favourable view.

MAFF represents the views of the fishermen through the Sea District Committees and the District Fisheries Inspectors. If fishermen feel that dredging will conflict with well-used fishing grounds, then they must express their opinion through the SFC's.

The MAFF review process is not as clear-cut as with the coastal erosion review. There is often a lack of information on the consequences of dredging. Many factors must somehow be resolved on the basis of little information.

Frequently, informal discussions will take place between MAFF, CEC and the dredging company to consider objections and to come to a compromise on conditions with respect to the granting of the licence.

The Marine Directorate of the Department of Transport is consulted by DOE to comment on potential navigation problems associated with dredging. This is of importance as there is a public right to unobstructed navigation to conduct trade and commerce in the tidal waters of the U.K. DOT, in turn, will consult with the organizations shown in Figure 3.1 to form their opinion on a licence application. There have rarely been objections as dredging vessels can maintain a great deal of maneuverability during operations and so do not greatly differ from most other ships. The DOT will impose conditions on a licence requiring dredgers to maintain a minimum distance from lighthouses and buoys and will restrict operations in harbour areas and approaches, and anchorage areas.

The Nature Conservancy Council (NCC) is a legislative body formed to create and manage marine areas of natural or historical significance. They have the power to restrict any activities, including fishing in specified areas. An unfavourable view will be given if a licence application is in an area managed by the NCC.

The Department of Energy comments on possible impacts on seafloor pipelines and on the offshore oil industry, which is under its jurisdiction. They will impose licence restrictions near pipelines and oil rigs. British Telecom comments on areas where there are telecommunications or power cables on the seafloor.

The Royal Navy (DOD) can restrict areas from dredging where they have a special interest.

There are many local authorities who may have objections to an extraction licence. These may include the Coast Guard, nautical surveyors, Regional Water Authorities and local businesses. In addition, the Sea Defense Authorities and Coastal Protection Authorities, which operate on a local level, may have specific objections not covered by HR.

After collecting all the opinions, DOE then decides on the "government view". The view will be unfavourable if there are serious objections to the licence. If objections can be managed through imposing conditions on the licence, then a favourable view with conditions will be given to the CEC.

The aggregate extraction review process has evolved in response to the primary concerns. Initially these were with navigation, but subsequent concerns were over coastal protection and, most recently, by fisheries. Presently, it is perceived by various participants of the review process that the concerns related to regulatory conflicts with the oil and gas industry will take on more significance. Exploration for hydrocarbons is moving closer to the shoreline, increasing the potential for conflicts between fishermen, dredging companies and oil companies.

3.3.3 CEC Review

If a favourable review is received from HR and DOE, then the licence for production will be issued along with any conditions stipulated. The licence is issued exclusively to a dredging company. The area which a

licence covers is typically on the order of 34 to 51 km^2 (10 to 15 nm^2) and tends to be 5.5 to 18.4 km (3 to 10 nm) offshore. Few licences have been granted within the 5.5 km (3 nm) limit.

The amount of material allowable for extraction is specified as a "maximum allowable annual tonnage". Royalties the CEC receives are negotiated on a case-by-case basis by the consultants to the CEC. The royalties are based on the Retail Prices Index and indexed to the inflation rate. The royalty rates are periodically reviewed to ensure they are in keeping with the real value of the material. The royalties are payable in two portions: (1) a fixed rent, based on a percentage of the maximum allowable annual tonnage; and, (2) a rate per tonne on all material extracted in excess of the percentage established in (1).

Licences are issued on an open-ended basis to a dredging company, and gives them exclusive rights for as long as the deposit can be worked. There are provisions for the withdrawl of licences (see Section 3.5.3), but the licence is not transferrable.

An important point to note is that there are no requirements for an Environmental Impact Study (EIS) as it is an implicit understanding that MAFF is to consider the environment when forming their opinion.

A list of dredgers presently in use in the U.K. is shown in Appendix 1 and the quantities extracted from 1965 to present are shown in Appendix 2. Aggregate from marine deposits presently accounts for approximately 15% of the U.K. market.

3.4 CODES OF PRACTICE

There have been two Codes of Practice established with respect to marine aggregate operations. One defines the relationship between the dredging industry and the CEC, while the other provides the basis for a working

liaison between the dredgers and the fishing industry. Neither of these codes have any legal or legislative framework but are used as an agreed upon method of conduct between the parties involved.

3.4.1 CEC and SAGA (Marine Section), 1977

This Code of Practice was published in March, 1977, and has the basic intent of defining licencing procedures, royalty payments and the power of the CEC (Appendix 3). It defines the six month notice period which is required to terminate a licence and the review process for royalty rates.

This Code explains the powers which the CEC have to investigate complaints of illegal dredging or licence infringement and the power to levy penalties on the company involved. These are discussed in Sections 3.5.2 and 3.5.3.

3.4.2 MAFF and SAGA (Marine Section), 1981

The "Code of Practice for the Extraction of Marine Aggregates" (Appendix 4) was introduced to provide a basis to encourage informal discussions between the fishing industry and the dredging industry during the application process. The objective of the Code "is to assist the development of working relationships between the fishing and dredging industries which minimize interference with fishing while facilitating dredging operations".

The salient points are found in Sections 2.5 and 2.6 and Annex A of the Code. Briefly, these encourage the dredging company to make contact with local fishermen to provide information on proposed operations. The fishermen in turn provide the company with information on locations where they would raise objections to dredging. It has been found that this informal process can reduce objections and conflicts during the formal review process.

The Code encourages dredging companies to provide the SFC with as much advance notice of dredging as possible and to proceed with dredging in a systematic manner. It also encourages the notification of the SFC when a

deposit will not be worked for a time. The intent of the notification is to allow fishermen time to remove gear from an area about to be dredged and to allow them to fish areas where dredging will not take place for a period of time.

The Code establishes time limits for the various stages during the consultation/application procedure.

3.5 LICENCING

3.5.1 Licence Conditions

Every organization which is part of the licence application review process can impose conditions on the licence in order for them to give a favourable view. These conditions are a way of ensuring that dredging impacts are minimized while still allowing the dredgers to conduct profitable extraction operations.

There are three basic conditions which all licences carry:

a) The co-ordinates of the area within which extraction is allowed;

b) The maximum annual tonnage which can be extracted from an area; and,

c) The royalties which must be paid for use of a licenced area in the form of a fixed fee plus a fee per tonne of material unloaded at the wharf in excess of a specified amount.

In addition, the licence may include operational constraints, based on comments from the government view, including method of extraction, water depth, or time period for operating. The maximum annual tonnage is based on estimates from prospecting results. Because of the difficulty in estimating the extent of deposits, and the lack of information available on the mineral resources, the maximum annual tonnage is usually determined from the amount a company requests for its operations.

When making an application, a company defines the desired area by a set of geographical co-ordinates. Restrictions imposed by the government view process may reduce the area available to be dredged. If a company wishes to extend the limits of the original licence, a new application process must be started, because the review process only considers the originally defined area. A new application would also be required if there was a change in the dredging method (e.g., from trailer suction to anchor dredging).

The co-ordinates defining the allowable extraction area will be outside exclusive zones as specified by the review organizations. Exclusion areas generally include harbours and approaches, herring spawning grounds, ocean dumping grounds and marine conservation areas.

Conditions imposed by HR may reduce the size of the licenced area. In particular, because of the rule-of-thumb 18 m stopline (no dredging in depths shallower than 18 m, see Section 4.2) most applications are outside this depth limit. The result is that few licences are for areas within 5.5 km (3 nm) of the shoreline.

The Department of Transport, Department of Energy, British Telecom and Department of Defense, may require exclusion zones, which may further reduce the requested licence area.

To protect fishing interests and still allow extraction operations, MAFF has occasionally required dredgers to operate only during specified seasons or, in the case of protecting sand eels, has restricted dredging to daylight hours only.

The agencies involved with the review process will generally require that the method of extraction be trailer suction dredging as opposed to anchor dredging. DOT prefers this method because it allows the dredgers to be maneuverable, reducing navigational conflicts. HR feels the coastal erosion impact from trailer suction dredging is less than with anchor dredging, and MAFF prefers this method because it is felt that the impact

on the biota and fisheries is reduced. Even the captains of the dredgers prefer trailer suction dredging because it allows them to operate in larger sea states compared to anchor dredging.

Up until the time of this report, there have been no conditions imposed on a licence which would require an environmental impact study, limit screening at sea, monitor dredger movements, or conduct pre/post seabed monitoring.

3.5.2 Monitoring of Licence Conditions

Monitoring vessel movement to ensure that extraction does not occur outside the licenced area is not routinely carried out. The CEC receives about 20 reports per year of infringements, generally from MAFF spotter planes on fisheries patrols, or from local observers.

After a complaint is received, the CEC begins an investigation. They will examine a ship's log, wharf records and dredging company records to attempt to determine if the dredger has been guilty of an infringement of the licence conditions. These complaints usually are difficult to prove because of the problem of determining the exact location of the dredger at the time of observation. There has only been one case where a dredger has been proven to be operating outside the permitted area.

The wharf records, dredging company records and royalties paid, are the only means to ensure the maximum annual tonnage to be extracted is not exceeded. There has been no evidence of this occurring, although this was a concern to some people within the fishing industry (see Section 4.0), due to the fact that the only records are those of the dredging companies themselves.

In the U.K., a number of ways to monitor compliance of the production licence have been considered. These include having inspectors on the vessels during extraction, conducting bathymetric or side-scan surveys of a dredging area on a periodic basis to determine the amount extracted and areas where material was removed, and recording positioning information.

The monitoring method which has received the most attention is referred to as "black box" or "electronic monitoring". The "black box" would monitor the ship's location during operations using a radio-wave or satellite navigational system. It has been argued that a system such as DECCA, which is the most common navigational system around the U.K., does not give the accuracy or resolution required to prove or disprove licence infringement. The accuracy will improve considerably, however, when the American Global Positioning System, a satellite navigation system, comes on-line in 1987 or 1988.

Unlike Canada, the U.K. does not require ships to report to the Coast Guard for the Notice to Shipping when conducting geophysical surveys or dredging operations. Such reporting would likely reduce some of the concerns related to illegal operations.

3.5.3 Penalties

There is not a prescribed penalty structure for companies which operate outside the limits of their licence. The most powerful tool which the CEC has is the right to withdraw an extraction licence on six months notice. The purpose of this requirement is to be able to protect coastal and fisheries interest if they are unduly influenced by extraction operations and to take action against operators who fail to comply with the conditions of licence (Code of Practice, 1977).

If the CEC does not choose to withdraw a licence after a proven licence infringement, then it may levy a fine of any amount against the dredging company. It is these two powers, the right to withdraw a licence and the right to levy fines outside of the judicial process, which the CEC uses to ensure the compliance of conditions of licence.

In some cases, the CEC may also suspend a vessel's licence or encourage the dredging companies to take internal action against persons who caused non-compliance of the licence without the knowledge of the dredging company. In fact, the CEC prefers the dredging companies to do their own policing over the conduct of their vessels.

The Marine Directorate of the DOT also has powers to halt extraction operations. Their authority within the territorial limit is derived from the Coast Protection Act (1949) and from the Continental Shelf Act (1964) for the U.K. continental shelf. This power comes from the public right to unobstructed navigation in tidal waters. If it is found that navigation is being obstructed, then the DOT will halt operations. There has been one case reported where extraction was halted after a navigation channel changed position due to shifting sand waves in the Thames estuary.

3.5.4 Compensation

A system has recently been set up in the U.K. to compensate fishermen for damage or lost gear caused by dredgers. Two basic problems exist. One is from screens or other debris discarded over the side of the dredging vessel, which are picked up in trawls. The other is related to fixed fishing gear, such as long lines, traps, or gill nets, which may be destroyed by the dredger's draghead.

If a fisherman picks up debris (screens), it has to be kept or photographed for evidence. The fisherman reports the incident to the SFC and the MAFF District Inspector. After the District Inspector has certified that the claimed amount for damage is reasonable, a claim form is sent to SAGA (or BACMI). There is no arbitrator and the dredging association either pays the claim or gives reasons for not doing so.

If the debris can be identified as coming from a particular vessel or company, then that company pays. Otherwise compensation comes from a central fund made from contributions from the participating dredging companies and organizations.

Compensation can still be obtained if the gear damage was sustained within a licenced extraction area. The Code of Practice (1981) requires adequate consultation with the fishermen on extraction activities, particularly if an area has not been worked for some time. If this does not occur, then a claim for compensation is considered reasonable.

4.0 CONCERNS ASSOCIATED WITH MARINE MINERAL EXTRACTION

4.1 INTRODUCTION

This section focuses on potential coastal erosion problems and on the concerns of the fishing industry, with respect to the extraction of sand and gravel from the seabed. The following sections include those issues reported in the literature, as well as concerns from individuals associated with the fishing industry, the sand and gravel industry, and government personnel, as determined from interviews carried out in the U.K. The issues have been separated into the following groups: (1) coastal erosion; (2) impact on fishing operations; (3) fisheries resource, habitat and environmental; and (4) administrative and management processes.

4.2 COASTAL EROSION CONCERNS

In the U.K., a rule-of-thumb, known as the 18-metre "stopline", has been in use which sets a minimum permissible depth where dredging can be allowed. The origin is based on a radio-active tracer study near the Isle of Wight (Anon, 1973), which showed no movement of gravel tracer, even under storm conditions, at 18 metres. The "stopline" was established because it was assumed that erosional problems would be minimized if dredging were allowed only in areas where sediment transport was unlikely to occur.

The 18 m minimum depth is considered conservative, since other studies have shown that there was no movement of gravel occurring at shallower depths (13 m) (Anon, 1983). The minimum depth at which movement of sediment is not affected by hydrodynamic forces (and hence a minimum depth for dredging operations) is dependent on site-specific factors such as sediment particle size, currents, waves, winds and other hydrographical conditions. Applications within the 18 m "stopline" are presently being considered by HR, depending on the location and site characteristics.

4.2.1 Altered bathymetry and/or lowered seafloor will result in changing refraction patterns, which may increase coastal wave energy, thereby increasing coastal erosion

The potential for damage to coastal beaches, communities and marine structures from changing wave patterns makes this a major concern. Motyka and Willis (1974) found that erosion increased when dredging in water depths less than 1/2 the normal wave length, or less than 1/5 the length of extreme waves.

This issue is quite site-specific, depending on hydrodynamic conditions, sediment size and bathymetry. For this reason, scientists at Hydraulics Research (U.K.) apply models which are conservative in nature, in order to determine whether there would be any risk from a particular extraction operation (see Section 3.3.1). Further research on the processes involved is required, however, to ensure that in areas approved for aggregate extraction will not cause erosion. As well, further study and a greater understanding of the processes may allow approval for extraction in areas currently excluded because of the uncertainity of the information.

4.2.2 The removal of protective bars or shoals may expose the coastline to increased wave attack

This concern is often related to the previous one, in that coastal structures and resources must be protected. The classic example of erosion caused by dredging is from the problems at Hallsands, Devon during the construction of the Plymouth breakwater in the early 1900's. The breakwater was largely built from material dredged offshore, but the removal of offshore bars resulted in severe wave damage to the coast and caused large scale erosion into the village. Along rocky coasts, however, it is not considered a major problem (Gillie and Kirk, 1979). Protective offshore bars or shoals are usually relatively close to the coastline but the location depends on the site-specific conditions including the degree of protection and topography of the area, and the tidal range. Bars in areas which have a gently sloping seafloor and large tidal flats tend to be further offshore. Coasts with a more steeply sloping seafloor are more likely to have offshore bars or shoals nearer to shore. Most bars can be found within 2 km (1 nm) of the coastline.

As with the other issues related to coastal erosion, each licence application must be considered independently, because of the site-specific nature of the hydrodynamic processes and sediment composition. In the U.K., Hydraulics Research looks at each application, setting limits to the licence to ensure that offshore bars are not destroyed.

4.2.3 Removal of selected size ranges will alter particle size distribution, thereby "contaminating" the area for subsequent extraction industries

If the composition of the bottom material differs from the current market demands, then some presorting will be carried out by the dredger. If gravel is discarded, then a layer of cobble may build up; if fines/sands are discarded, then a layer of fine sediment is created (Gillie and Kirk, 1979). In either case, subsequent dredging is even further affected which could ultimately result in the abandonment of an area. In the U.K., this is known as "fouling the nest". In the short term, this mainly affects the economic viability of an operation, but it also can have implications for long-term planning purposes. There may be fishing industry conflicts if an approved dredging area is abandoned, directing pressure for extraction in new areas. (The issue related to the biological recolonization of an area which has undergone substantial change in particle size composition is discussed in 4.4.3). A related concern, but not voiced during the interviews, is that the holes left by dredgers (generally anchor dredgers) may fill up with mud (Dickson and Lee, 1973; Gillie and Kirk, 1979), which may have implications with respect to biological recruitment (see Section 4.4.1). This would only occur in areas where there is an availability of mud. In the U.K., sand and gravel deposits commonly overlie existing clay beds (Rowland, 1985).

In practice, dredgers in the U.K. know approximately where they can obtain the composition of sand/gravel they require, which reduces the rate of contamination of any one site. However, the sand/gravel mix required by a company is based on market demands, which can change quickly. After unloading a particular cargo, a dredger may be required on the next trip to

obtain a completely different product. This is used, in part, as the rationale for having large, numerous licence areas each with lengthy time frames in order to meet continuously varying demands of the aggregate market. These rapid changes in plans also present difficulties in notifying fishermen (see Section 4.3.2).

There are two ways of dealing with these concerns, although neither is practiced in the U.K. One is to limit the amount of pre-sorting done on-site, requiring the company to sort and stockpile various aggregate components on-shore. The second, somewhat complementary method, is to have sufficiently detailed information on the resource to allow a dredging operation to select the specific product required. The improved information base would likely reduce the need for larger licence areas, which, in turn, would reduce conflicts with the fishing industry.

4.2.4 Altered bathymetry or removal of selected particle sizes will affect on-shore/offshore sediment transport patterns

This concerns source material for coastal beaches; if material is removed or altered by offshore extraction, then the beach formation processes may be affected, and a beach itself may suffer damage or even erode away. A few studies have been carried out (e.g., Joliffe, 1974; various internal studies at Hydraulics Research, pers. comm., Dr. A. Brampton), but no conclusive evidence exists.

The potential or degree of damage is likely to be site-specific, and must be reviewed by coastal erosion experts, as described in Section 3.3.1.

4.2.5 Dredged holes or furrows persist in the seafloor

The persistence of the holes or furrows left by dredging is a function of the size distribution of remaining sediments, the water depth and hydrodynamic forcing by waves and tidal currents. In general, gravel in the English Channel shows movement only during storms (Kidson, 1959; Dickson and Lee, 1973; Anon, 1983) so the rate of infilling can be expected

to be slow. Cressard (1981) estimated that the infilling of holes in coarse material (gravel) would take up to 25 years while in sand, trenches may be covered within a few hours to up to six months (ICES, 1979). The persistence of the holes depend upon the site, but generally furrows left by trailer suction dredging will infill faster than holes left by anchor dredging (Gillie and Kirk, 1979).

The persistence of dredging furrows was not a significant concern with respect to coastal erosion, although the Hydrographic Office of the Navy, who maintains the Admiralty charts, does occasionally require information on the size of dredging furrows.

4.2.6 Altered seabed bathymetry alters current patterns

The currents at a site are dependent upon the bathymetry of the area, the water depth and the forcing mechanisms from tides and wind. Areas that may have altered current patterns would be shallow, coastal places such as estuaries and harbours. Because most of the dredging in the U.K. takes place in water depths greater than 18 m, and generally more than 5 km (3 nm) offshore in open sea conditions, any changes in current patterns due to dredging would likely be insignificant. This concern is not considered a problem by most of those interviewed in the U.K.

4.3 IMPACT ON FISHING OPERATIONS

4.3.1 Discarded debris from dredging vessels, particularly used screens, damage bottom gear

This is considered a major issue with the fishing industry. The screens (roughly 2 m x 2 m) which are used to sort the sand and gravel may last only a few hours and the dredging industry has a history of discarding these over the side. Fishermen subsequently pick up these screens in their bottom trawls, resulting in torn or lost gear.

MAFF has established a compensation plan for damaged gear between the fishing industry and the sand and gravel industry, and dredgers have been requested to retain used screens for shore disposal. The compensation scheme is still experiencing initial difficulties, at least as far as the fishery industry is concerned. In one area alone (Lowestoft) as many as 35 screens may have been dredged up in 1985. However, the length of time (eight months) to receive compensation and the fact that it didn't cover replacement costs, has resulted in a general feeling of disappointment.

Regardless of the actual number of screens picked up, and whether or not they represent historical or current dredging practices, the issue has become, in part, one of a lack of trust and co-operation between the two industries, in spite of the fact that the Code of Practice (1981) (Section 3.4.2) was intended to facilitate communication between them.

It has been suggested that permanent identification of screens along with inspection of outgoing and incoming manifest forms to ensure the return of any screens replaced would virtually eliminate this issue. A similar scheme has been instituted for materials used in offshore oil exploration and production.

Increased co-operation of the extraction industries in this regard, and in understanding the problems that discarding debris offshore can cause, would greatly enhance relations with fishermen. It has also been suggested that an independent board should administer the compensation plan, rather than the present system, in which the sand and gravel industry alone decides on whether or not the claim is legitimate.

4.3.2 Extraction practices displace the local fishing industry, resulting in a loss of livelihood for some individual fishermen

This is a major issue and one which causes some internal conflict within government regulatory agencies. It relates to the fact that while the overall fishery resource may not be affected by the activities of dredgers, the ability of individual fishermen to work their favourite areas may be

affected if dredging is also being carried out. In other words, the two operations cannot be carried out at the same time, in the same area. It is an issue related to loss of access.

In the U.K., it is government policy to increase the percentage of sand and gravel obtained from marine sources, due to the fact that land-based sources are becoming scarce, and there is increasing conflict with other land uses, particularly agriculture.

The long-term effects of marine sand and gravel extraction are not known, and research projects in this area have been inconclusive. However, it is generally accepted that on a regional scale overall fish stocks are not likely to be significantly affected, although there may be some site-specific exceptions to this, such as local spawning herring stocks. The reasoning is that the size of the area involved for sand and gravel extraction is small relative to the entire fishing grounds. In addition, it is believed that adult fish will rarely be caught, and while they may be displaced and move to other areas, these fish will probably be able to find alternative habitats and food sources.

However, while problems may not develop on a regional scale, the disruption of local fishery grounds by dredgers can severely restrict the options of some fishermen, especially those of the inshore fleet whose range is limited due to the size of their vessels.

The only way to minimize this conflict is to ensure that key fishing areas are excluded from licence areas. It is important that these areas be identified from an established data record, thereby avoiding claims of over-reaction which are occasionally leveled at fishing organizations. In addition, it is equally, if not more, important to be able to identify alternative sites for the sand and gravel resource. The proper information base would enable managers to reduce conflict in areas of high fishing potential, while at the same time, allowing the extraction industries access to their resource.

4.3.3 Unannounced extraction activity interferes with the fishing industry and/or results in damage or loss to fishing gear

This issue is also a major one for the fishing industry and stems from the fact that large portions of existing sand and gravel licence areas often remain unused for considerable lengths of time. During periods of inactivity, fishermen will occupy the area. The problem occurs when the dredger returns and disrupts and damages fishing gear, primarily long-lines, traps, gillnets and drift nets.

The Code of Practice (1981) (see Appendix 4) stipulates that the local fishing organization be notified of dredging activity. However, as pointed out in Section 4.2.3, the decision by a dredger to proceed to a new location can be made quickly (less than 24 hours) with very little lead time for informing fishermen.

The solution lies in co-operative and timely information exchange. Fixed gear can take over 24 hours to retrieve and thus, at a minimum, notice should be given two days in advance. The situation would likely be further aleviated if the licence areas, particularly for prospecting, were made smaller (see Section 4.5.2).

4.3.4 Extraction activities are carried out beyond the terms of the licence (with respect to geographical limits and/or timing) and interferes with the fishing industry

This was a concern of some of the fishing industry organizations, but stems mostly from the lack of trust and co-operation that has developed over the years between the fishing industry and the offshore sand and gravel industry. Claims that dredgers are usually in violation of their licence are difficult to substantiate, although most complaints are, to some degree, investigated by CEC, but resources are limited and generally the coverage is low.

One suggestion to resolve the issue has been to record positioning and operational information for use by CEC or others to ensure compliance with the terms of the licence. It has been argued that this "black box" would be too costly, partly because of the costs of the positioning system itself. However, the benefits of improved positional information for locating and managing the sand and gravel beds (see Section 4.5.1) would mean that the incremental cost of a recording device is much lower. For example, a LORAN-C system in the case of Canada (similar to DECCA used in the U.K.) could provide positional information within a ship's length (60 metres). Cost of a receiver and data logger would be about $5,000 CDN.

It has also been argued that informing fishermen on the activities of the dredgers (e.g., when and where they will be operating) would improve relations between the two industries. Provision of such information would likely increase the incentive of dredgers involved to comply and would assist in monitoring (by others) of their activities.

4.3.5 Furrows or holes left by a dredger may damage fishing gear or severely impair gear efficiency

The uneven seabed topography caused by dredging can affect the hauling of long-lines and traps and the efficiency of bottom trawls (Miller et al., 1977; ICES, 1974). In particular, the large craters left by anchor dredging are considered a major problem, and in fact, it has been recommended that this form of dredging be disallowed (Cressard, 1981). The fact that such craters do not quickly fill in (see Section 4.2.5) adds to this concern.

Trailer suction dredging is generally believed to be a more acceptable method for extracting bottom material and the furrows left should not greatly affect the action of bottom trawls (ICES, 1974). Because of this and other constraints such as navigation, anchor dredging for aggregates is not practiced in the U.K., although some vessels are used for navigation channel maintenance work.

4.3.6 Extraction may expose boulders or other natural objects, increasing the potential for damaging fishing gear

This is not a widely-voiced concern, although it was discussed by Miller et al. (1977). There is no evidence of this actually occurring and it was generally believed that it would be difficult to establish whether a boulder was already present, exposed by dredging, or exposed by natural processes. (In some areas, sand waves of up to 4 m in height can move during a storm event). The furrows created by trailer dredging are usually quite shallow (less than 0.5 m) and the potential for increasing the exposure of boulders is considered slight.

Regular monitoring surveys of active licence areas been suggested (Section 5.5.3). One benefit, if side-scan sonar is included, is that any newly-exposed object would be reported, although this concern alone would not justify the expense of a monitoring program.

4.4 FISHERIES RESOURCE, HABITAT AND OTHER ENVIRONMENTAL CONCERNS

4.4.1 Mineral extraction disrupts and alters the seabed, damaging existing biota and affecting subsequent recruitment

This is a major issue for fisheries officials and fishermen, and stems from a generally protective environmental attitude. Because of the long history of the fishing industry, and because it is considered a renewable and continuing resource (as opposed to sand and gravel reserves, many of which are relict and not replenishable) any threat to that resource is resisted.

It is acknowledged and accepted by most that significant damage to benthic species will occur in areas dredged. If the area worked is large, then the concern is whether or not the benthic community would recover, and over what period of time. The implication is that a commercial fishery may not return if the benthic community is damaged or destroyed, or if significantly altered.

Research in this area has not been extensive and results are inconclusive. Several studies (Shelton and Rolfe, 1972; Dickson, 1975; and deGroot, 1979a) pointed out the relationship between substrate type and the benthic species present, and the importance of leaving a similar type of substrate after dredging.

While there is a clear relationship between dredging and the loss of epibenthic and benthic species (ICES, 1979), the time required for recovery has not been established. Cressard (1981) reported that recolonization of dredged areas seemed to be slow. Millner et al. (1973) believed that the re-establishment of the benthos was dependent on the nature and stability of the sediments, but that it would require a very long time before a stable benthic community is achieved. deGroot (1979b) estimated that in the North Sea, recovery takes approximately two years while under Arctic conditions, the recovery period may exceed 12 years.

The most recent relevant research projects were carried out by MAFF research scientists. The results have not been formally published but are included in the ICES reports (1977 and 1979). The results were not conclusive. No permanent damage over the two year study period was identified and overall recruitment appeared to be normal. However, the study was not considered, by some, to be sufficiently long enough and the substrate in the region was not believed to be representative of many of the areas currently being assessed for sand and gravel licences. Follow-up research has not been carried out and the long-term impact of dredging remains uncertain.

In the absence of definitive assessments of long-term damages, decisions regarding applications must be based on potential damage in the short term. Even in this regard, the information base is quite weak, although it is acknowledged that the informed judgement of fisheries research personnel can be very valuable.

One way to alleviate the concern is to conduct surveys showing the biological resource base, especially for herring and sand eel (see Section 4.4.2), along with potential alternative sites for sources of sand and gravel.

4.4.2 Mineral extraction will damage herring spawning grounds and the habitat for other species, particularly the sand eel

Most fish will avoid dredging operations by moving to new locations. Since many of these species have pelagic (floating) egg and larval stages, direct impact by sand and gravel extraction is very low. Two exceptions which are of major concern to fisheries officials are herring and the sand eel (or sand lance in Canada).

The herring is one of the few species (and the only commercial one) which spawns in offshore gravel areas, preferably on ridges in high energy environments (deGroot, 1979a). Since these areas are often sought by the sand and gravel industry, the potential for conflict is high. In the North Sea, many of the coastal areas have been identified as having potential for herring spawning. However, very little is known as to which are actually used and without unequivocal knowledge of spawning sites, it becomes difficult to support recommendations to exclude sand and gravel operations. The importance of consulting local fisheries officers and fishermen to determine known spawning areas or those having a high potential for spawning, is stressed. In addition, it has been suggested that pre-application surveys be conducted during the spawning period to determine the degree of utilization and the necessity for avoiding dredging during this period.

Sand eels, while not fished commercially, are an important food species (ICES, 1974). The fish lay their eggs in the sand and bury themselves during the night, feeding and swimming during the day. Pre-application surveys for sand eels have been suggested, while other mitigative measures include dredging only during the day, and/or to limit extraction activities to the winter and spring to allow summer recovery (deGroot, 1979b).

4.4.3 Altered seabed composition will affect subsequent benthic populations and fish species present

The consequences of pre-sorting and disposal of unwanted material on subsequent extraction activity was discussed in Section 4.2.3. However, there was also a concern that by significantly altering the size distribution of the bottom sediments, there would be changes to the benthic organisms which recolonize the area which could potentially affect future fish stocks. While there have been no studies which have directly addressed this concern, it is generally accepted that the nature of the bottom fauna is closely related to the substrate and in particular, particle size (Dickson, 1975; ICES, 1979).

Several suggestions have been offered to mitigate against this potential problem. Licence areas should not be issued in regions where the deposit is thin, and where there is potential to expose bedrock, clay or other substantially different underlying material. In areas where the desposit thickness is adequate, repeated dredging over the same site should not continue to the point where the underlying material is exposed. Both require detailed "pre-application" surveys on the nature and extent of the resource; the latter requires accurate positioning and periodic monitoring.

It has been suggested that to avoid changing the nature of the substrate by depositing unwanted sediments on site, all material extracted should be retained on the vessel, with any sorting required carried out on land. In short, the material remaining on the bottom should be similar to that taken by the dredging vessels.

4.4.4 Mineral extraction releases fines from the sediment resulting in turbidity plumes and subsequent siltation of the sea bottom

Turbidity plumes from dredging of harbours, channels or for projects such as pipeline installation, have been well reviewed (e.g., Bowen, 1981; ESL, 1982; Herbich and Greene, 1975; Levings, 1982). In general, the effects of turbidity on phytoplankton (light reduction) or on pelagic fish and

invertebrates (gill irritation; reduction of light levels affecting visual feeders) are considered small (Cressard, 1981; deGroot, 1979b). Fish may actually be attracted to dredging sites, to feed on animals stirred up by the operation (deGroot, 1979). A major factor is the fact that the plume is generally small in scale, relative to the overall marine coastal environment, and short in duration.

Reviews or studies conducted relative to sand and gravel extraction have indicated that the impact of fines from such activities (Dickson, 1975; Millner et al., 1977) is small and frequently the material is quickly dispersed (Gillie and Kirk, 1979; Cressard and Angus, 1982). Most sand and gravel operations avoid areas with any significant amount of fines (e.g., > 5%) because it contaminates the cargo. The desired mixture of sand and gravel for aggregates is 60% gravel and 40% sand. In addition, these operations also are not of long duration; a single vessel may spend only 3 to 4 hours in a 24-hour period actually on location, with the remaining time spent in travelling & off-loading.

The distribution of dispersed fines is of some concern to fisheries personnel. Millner et al., (1977) addressed this issue with respect to the smothering of eggs and fish larvae by fines, but concluded that the outwash material from a dredging vessel would not have a signficant effect, especially in areas with high natural turbidity due to tides or generated by storm waves. Problems can occur, however, if sand and gravel extraction occurs near aquaculture sites, particularly near shellfish areas such as mussel operations. Turbidity plumes near river mouths may also affect migration patterns of diadromous fish. These problems are more likely to occur with placer mining operations than with aggregate extraction. The former is discussed in further detail in Section 5.6.

The degree of concern expressed will be site-specific and will depend on the extent and nature of the resource perceived to be affected, the amount of fines in the bottom material and the extent of the actual mining operation. The distribution and settlement of fines is an issue which has

been raised in at least one region in the U.K. where there is a concern over the impact of silt deposition on crabs, particularly females carrying eggs.

The complete resolution of this issue would require both site-specific information (such as the amount of fines in the material; current information, to model dispersion patterns, and the extent and quantity of biological resources) as well as general research on such items as the effects of siltation on specific species of concern, or improvements to the numerical models used to determine dispersion patterns.

4.4.5 Mineral extraction affects water quality with respect to released toxins and/or dissolved oxygen levels

This issue is related more to dredging of areas such as river channels and harbours, where industrial development results in the accumulation of contaminants (e.g., trace metals such as copper, lead, zinc, mercury, PCB's) and organic material in the sediments. The sediments frequently are anaerobic with high levels of hydrogen sulfide. The concern is over the release of these toxic compounds and a general lowering of the oxygen in the waters due to the high biological oxygen demand (BOD) of the sediment when the bottom is disturbed during dredging.

With certain localized exceptions, such as enclosed areas with high sediment accumulation, the impact of dredging is unlikely to be major and the consequences limited to the (generally) short period when excavating is underway (Dickson, 1975; Lee et al., 1975; Chase, 1976). With respect to sand and gravel extraction, there is even less cause for alarm since high levels of fines (which are generally associated with the problems of toxic substances and oxygen depletion) are avoided.

The concern can be alleviated by conducting surveys prior to the licence application to determine whether fines are present and the possibility of problems associated with contaminants or BOD. The surveys would be carried out during the assessment of the sand and gravel resource and the biological resources (see Section 5.5.3).

4.4.6 Dumping of contaminated cargos (e.g., with too much silt) or marine discharge from the dredging vessels creates a "bottom pavement", thus affecting fishing efficiency and fishery

Cargos heavily contaminated with silt or clay could not be used (by the aggregate industry) and presumably would be jettisoned. There were some complaints that this formed a "pavement" on the bottom which damaged fishing gear and reduced the potential of the area as a fishing ground. This was not a widely-voiced concern and there was no information to substantiate the claim.

Presumably, such dumping does occasionally occur, although it is in the operator's best interest to minimize any contamination. Generally, while extracting for sand and gravel, the suction heads are raised at the first sign of silt or mud.

Any cargo that is dumped would cover only a very small fraction of the overall bottom and it was believed unlikely that it would consolidate into anything like a hard bottom. At worst, it is thought to be a relatively uncommon event.

4.5 ADMINISTRATIVE AND MANAGEMENT CONCERNS

4.5.1 Lack of resource information for both the sand and gravel industry and the fishing industry, severely limits the planning process

This is perhaps the most often cited and biggest concern related to the conflicts between sand and gravel extraction and fishing. Both industries acknowledge the right of the other to operate, but at the same time recognize that the two industries are mutually exclusive - at least during the same time and at the same place. Thus, the more information one has on the nature of the resources (mineral and biological), the easier it is to resolve conflicts.

One example of how this information can be used is when an applicant identifies an area for sand and gravel extraction which is also considered to be a sensitive or significant biological resource. If the regional distribution of the sand and gravel reserves are well known, resource

managers and regulatory agencies can suggest alternative areas for development, which may be less sensitive biologically. In addition, the dredging companies themselves can utilize this information, reducing potential conflicts.

Because so little is known about the biological resources of some areas, there is often a conservative approach to protecting these areas in the absence of information. More detailed surveys would allow resource managers to make better conservation decisions while still permitting both industries to operate (Cottell, 1978; ICES, 1979).

A related problem is access to sand and gravel reserves within the 18 metre stopline. By automatically rejecting operations in depths less than 18 m, large areas may be unnecessarily eliminated. Continued research on coastal erosion processes and consideration of site specific situations (e.g., extraction of sand and gravel near bedrock coastlines) has been suggested.

One of the first stages in building up the necessary data base is accurate mapping of the surficial geology (e.g., sand and gravel beds or potential placer deposits) on a regional scale. This would allow dredging companies to focus on more detailed prospecting over a much smaller geographical area, to determine commercial viability. This would, in turn, alleviate concerns related to prospecting over large areas and unannounced prospecting operations (see Section 4.3.3). In the U.K., data on the nearshore areas are particularly sparse since many survey vessels are too large for the shallow waters and must operate further offshore. A similar situation exists in Canada, yet it is these nearshore waters that are most amenable to sand and gravel extraction.

The question of grid size or sampling frequency required for resource management mapping depends upon the variability of conditions in the area and the geological knowledge available. Core and grab samples are used to calibrate the geophysical data from side-scan sonar and shallow seismic surveys. The density of sampling is subject to the lateral variation in the samples; something which cannot be determined beforehand. In the U.K.,

it is generally felt that a sampling interval of 1 km (0.5 nm) is sufficient for resource management mapping, although it has been suggested that if the sampling interval were reduced to 0.1 km, the reserve estimate may change by as much as 30%.

Because of the more dynamic nature of the coastal and nearshore zones, the sampling interval in these areas must be smaller to provide detailed information on reserves. However, even the sampling intervals suggested above may not be sufficient to give accurate data on resource quantities, although it would provide data on the spatial distribution of the resource.

The lack of good resource definition can, in part, be attributed to the nature of present prospecting instruments and techniques. The common methods for defining surficial sediments are with side-scan sonar, multi-frequency echo sounders, grab samples, seabed cores and bottom photographs. With the exception of side-scan sonar and sounder, these provide information only for that particular point in the seafloor that was sampled. Between these sample points, the information must be interpolated. To obtain the coverage required to accurately define the resource, using spot sampling techniques, is both costly and time-consuming. These techniques also may distort or provide an inaccurate representation of actual conditions since cores and grabs tend to exclude large-sized material, such as cobbles. Present practices in the North Sea include a combination of side-scan and coring with a 150 mm barrel.

The preferred method for prospecting is to use continuous sampling instrumentation such as side-scan sonar, for bedform and material definition, and shallow seismic profiling for thickness of layers. The use of seismic profiling has not been very successful as high frequency signals do not penetrate gravels well and low frequency signals do not provide the necessary resolution. Experts in the U.K. have stated that seismic surveys are no longer used as a prospecting tool because the instruments do not allow sufficient resolution to identify the thin deposit layers (0.2 to 0.5 m), generally found around the U.K. However, the "boomer" type system operating at 300 Hz is still the only continuous profiling method for

determining sand and gravel thickness. If the deposit is less than 1 metre in thickness, continuous profiling systems (CPS) are not particularly useful since they lack the necessary resolution. However, if the deposit is 5 to 10 metres thick, sub-bottom profiles can be used to determine the thickness of a deposit. Side-scan sonar, while providing excellent information on the lateral extent of a resource, provides nothing on thickness. A multi-frequency echo sounder is also useful for assessing bottom substrate type (sediment size, bedforms) and is frequently cheaper to operate than a side-scan.

To overcome these difficulties, there has been a call for a dual-source acoustic system, which would include a combination of side-scan sonar and shallow seismic profiler, to give both the resolution and penetration required for resource mapping. The use of an instrument of this type for resource mapping must also be integrated with a precise navigation system and a digital datalogging system to extract a maximum amount of information from the surveys. Precise navigation would also allow the dredging companies to more closely define the size of the resource, thus enabling efficient recovery once a production/extraction licence is issued.

Instruments such as sonars and acoustic profilers still require considerable ground truthing with cores and grab samples. Bulk sampling (without using a dredging vessel) can be accomplished with corers or, more easily, with an air lift sampler. Without some type of physical sampling, the quality, and often the quantity, of the deposit cannot be determined.

Along with improving the geological data base, more information on the biological resource is required in order to identify critical fisheries habitats. One suggested format is to present the data as a series of map overlays. This would permit operators to focus on alternative sites, thus minimizing conflicts.

4.5.2 Areas authorized for prospecting are too large and there is no consultation process during this stage

Many fishing associations and individuals were concerned that "the entire English coast is under licence" and they perceived this to be a threat to their livelihood. In addition, since dredging vessels are entitled to prospect anywhere within these licenced regions and several companies may be prospecting in the same area, there have been conflicts with the fishermen, especially those using fixed gear.

Conflicts develop if dredging vessels appear without warning, interfering with normal fishing activities. In addition, if the vessel is extracting sand and gravel, it is not possible to determine whether the dredger is in compliance of the prospecting licence or non-compliance of a nearby extraction licence.

The basic issue is primarily one of a lack of information and communication. The fishing industry would like to be kept informed at all stages of the licencing process. In cases where some individual companies have gone to local fishing organizations at the prospecting stage, as has happened in Scottish waters, considerable improvement in the relations between all parties involved was reported. In general, however, especially in the southern regions of the U.K., a general atmosphere of mistrust exists which frequently impedes effective dialogue and exchange of information.

There were a number of suggestions to help resolve the issue. One was to make the prospecting licence area exclusive to one company, which would oblige them to keep the fishermen informed of any licence restrictions and of their intent and progress. It is the exchange of information which will probably be most effective in minimizing the conflicts of two users of the same resource. In concert with this exchange, improved surveillance and monitoring of the terms and conditions of each operator's licence (e.g., by recording position and operating information) would reduce the concern over non-compliance (see Section 4.5.3).

4.5.3 Surveillance and monitoring of the terms and conditions of licence is insufficient to detect violations

A major concern of fishing organizations is that operators are not adhering to the conditions of the licence. The issue is primarily one of mistrust resulting from early conflicts with marine sand and gravel extraction. (Note that this is perceived to be more of a problem along the southeast of England, where the sand and gravel industry has been operating for many years, compared to Scotland, which has only recently been considered for marine sources of aggregate).

Surveillance of marine aggregate operations has been carried out by MAFF but the agency is severely restricted due to budget constraints. The ultimate authority is the CEC who will investigate all legitimate complaints and in a few cases, have leveled fines and other punative restrictions (see Section 3.5.3).

A sealed "black box" recording device has been suggested as a means to resolve this issue. The instrument would record both operational data of the vessel (e.g., whether or not material is being extracted) and position (time, latitude and longitude) for submission to regulatory authorities.

This type of device was considered too expensive to justify it becoming mandatory, but this was due, in part, to the costs of the positioning system itself. However, the requirements for precise positioning on dredging vessels have been increasing in response to a need for more detailed information on the aggregate resource. As the costs for the electronic navigation systems go down, and the need for more precise information increases, the cost of installing a "black box" system is not likely to be prohibitive.

4.5.4 Local fishing associations do not have direct input to the permit/ licencing procedure, and do not have an opportunity for appeal

The licencing procedure in the U.K. is described in Section 3.1. Individual fishermen must direct their concerns to the local fishing organization which is responsible for ensuring that the local fishery officers are informed. The fisheries officers relate the concerns to MAFF headquarters where the information is consolidated with other MAFF interests and presented as a part of the "government view".

This issue is related to the perception that MAFF must wear two hats - protecting the fishery resource and representing individual fishermen. Thus, situations can arise where there may be only minimum impact to overall fish stocks, but problems arise if the area licenced for sand and gravel extraction is part of a fisherman's favoured grounds.

The Code of Practice (1981) encourages direct communications between the dredging industry and local fishermen. In areas where an atmosphere of mistrust has not built up (such as Scotland), this interaction appears to be successful. However, a more formal input by fishing associations to the regulatory process is believed to be desirable.

There was also a need expressed to provide a mechanism for allowing independent appeals over an administration decision. In the U.K., unresolved issues are only those between government agencies, which are settled at the ministerial level.

4.5.5 The Crown Estate Commissioners (CEC) is perceived to have a vested interest in the issuance of a licence

The CEC is the trustee of all offshore mineral resources and collects royalties on behalf of the crown for all sand and gravel extracted. The CEC is also the regulatory authority which issues the licence, and while it receives input from other government agencies, the CEC has the final say. (In practice, it is highly unlikely that a licence would be issued if a negative government view was voiced). Again, the fishing industry is uncomfortable with this arrangement, partly because they have no direct input (see Section 4.5.4).

One alternative arrangement for the U.K. situation is an independently-appointed commission which would arbitrate on all licence applications. Government agencies, fishermen and fishing organizations, sand and gravel organizations, and any other individuals or groups who have a vested interest, would all present, in a formal hearing, their positions. The CEC would be involved only in settling the royalties.

This type of process would help alleviate a number of concerns. Everyone would have access to critical information and would have direct input into the approval process, and by making it a formal hearing, positions would have to be substantiated by information and not by speculation. The CEC would be seen to hold a more neutral position.

5.0 MAJOR ISSUES RELEVANT TO CANADIAN WATERS

5.1 INTRODUCTION

The previous section addressed the numerous issues or concerns associated with the extraction of sand and gravel from marine waters offshore the United Kingdom. The focus was on (a) the potential impact on coastal erosion processes and (b) interactions with the fishing industry.

This present section discusses those concerns which are considered to be relevant, requiring some mitigative measures for marine sand and gravel (or placer mining) operations in Canada. A number of potential sources have been identified, particularly off the east coast (Miller, 1981; Arnold, 1985; Fowler and Miller, 1985; Hale and MacLaren, 1984; Pasho, 1985; G. Fader, Atlantic Geoscience Centre, pers. comm.), and the Beaufort Sea (Cuddy, 1985; O'Connor, 1985).

The report has focused on sand and gravel because most of the interactions between the dredging and fishing industries, and the regulatory review procedures, have been associated with this resource. However, placer deposits, which have been identified in Canada (e.g., Hale and MacLaren, 1984; Coughlan, 1985; Fowler and Miller, 1985), share many of the issues with aggregate extraction and a discussion on placer mining is included in Section 5.6.

5.2 COASTAL EROSION

In the U.K. the first stage of any application for extracting sand or gravel is to determine whether there may be any potential impact to coastal structures or shorelines. The concerns include:

- changes in wave refraction and sediment transport patterns;
- removal of protective bars; and,
- changes in residual sediment types due to selective extraction ("nest-fouling").

While there are no major operations for aggregate extraction on the east and west coast of Canada, there has been considerable activity in the Beaufort Sea, associated with the building of islands and berns for offshore drilling. In 1982, for example, the total amount of material

removed in the Beaufort (14.7 million tonnes) was nearly equal to the entire U.K. production (16.7 million tonnes) based on data from Tayler et al. (1985) and from Appendix 2.

5.2.1 Wave Refraction and Sediment Transport

Wave refraction changes and alteration of sediment transport patterns have been effectively minimized by restricting U.K. operations to depths greater than 18 m. However, the data base supporting the 18 m stopline is not large (see Section 4.2) and was related to a specific site, and further research in this regard is recommended.

The 18 metre minimum depth is a conservative approach and no erosional problems in the U.K. have been associated with the use of this guideline. However, if followed exclusively, this would eliminate the use of many potential deposits, restricting aggregate mining to a narrow band since the maximum operational depth of most vessels is 35 metres.

In order to address the issue that potentially commercial Canadian deposits be considered, it is suggested that the review process for coastal erosion concerns be carried out in three stages, as illustrated below (note that these criteria are for coastal erosion considerations only, not fishing industry, fisheries or other environmental concerns which would be independently assessed):

a) **Deposits in 20 metres or greater:** approval is likely to be straight-forward and would require only a desk review (see Section 3.3.1), based on experience and research carried out in the U.K.;

b) **Deposits in 10-20 metres:** in this depth range, potential coastal erosion problems will be a function of material size, and hydrogeological conditions, and the physical nature of the shore zone. A more detailed review and some site specific information may be required to support an application; and,

c) **Deposits in depths less than 10 metres:** this depth interval may require substantial study before an application for aggregate extraction could be approved.

The re-introduction of finer-sized material may also have an impact on the existing biological community or in the nature of recolonizing organisms. This issue is discussed in Section 5.4.3. A series of steps to determine whether the dredging operation would affect wave refraction patterns or increase exposure off the shore to larger amounts of wave energy, was also discussed in Section 3.3.1. The steps could include computer modelling, site-specific field studies or even construction of a physical model. In the U.K., the Hydraulics Research Laboratory, a government-research institution that has been recently privatized, undertakes these reviews under contract. The equivalent institution in Canada is the Hydraulics Laboratory of the National Research Council (NRC), which has the required expertise, computer modelling capabilities and physical modelling capabilities. These facilities are also available at some universities (e.g., Queen's) and private consulting firms.

5.2.2 Protective Bars

Removal of protective bars should not be permitted as these bars form a basic defence against wave attack on the shoreline.

5.2.3 "Nest Fouling"

The fines separated during the sorting process are dispersed in a plume while the heavier sands tend to fall more directly to the seabed, covering the original deposit. It is not in the best interest of the operator to create a significant change in the mean particle size of the deposit. If an overburden of finer-sized sediment is created, the operator must pump increasingly more material to achieve the desired sand/gravel mixture. It is not economical for an operator to dredge through an overburden who will endeavor to minimize the amount of material re-deposited. One procedure to reduce "nest fouling" is to have detailed information on the deposit reserves so that only material close to the size range sought by the contractor is extracted. Another method, which is likely more costly and would require considerable shore-based infrastruture, is to not sort at sea but return to shore with the entire cargo, sorting the various size categories on land.

It is recommended that the reviews, outlined in Section 3.3.1, also be carried out for any sand and gravel (or placer mining) operation in Canadian waters.

5.3 IMPACT ON FISHING OPERATIONS

Of the seven issues identified, with respect to the conflicts between the fishing industry and the sand and gravel industry, four appear to be of particular importance if offshore aggregate or placer mine operations are expanded in Canadian waters. These four issues include:

a) the marine disposal of debris, especially sorting screens;

b) sand and gravel companies operating outside of the terms of their licence (geographical, timing or allowable cargos);

c) unannounced dredging activity interferring with fishing operations; and,

d) displacement of local fishing industry by sand and gravel extraction activities.

5.3.1 Debris

This issue can be resolved with appropriate management procedures in place. However, it also requires members of both the fishing and dredging industries, but particularly the latter, to operate in good faith. Disposal of any object is not allowed but was widely practiced in the U.K. during the early years and claimed, by some, to be continuing. In Canada, by ensuring that all screens (and other potentially disposable gear) are marked so that the company can be identified, coupled and manifest forms to record the movement of material to and from the shore, this issue should be satisfactorily resolved.

Using manifest forms would ensure that disposable gear is not dumped at sea. A record (manifest) of the amount of gear loaded on the ship is kept by the wharf operators, copies of which would go to the operators and the regulatory agency. The amount of gear unloaded from the ship is also recorded so that any discrepancies between the gear loaded and that unloaded would be immediately obvious and brought to the attention of the authorities. A similar type of management scheme has been used successfully for offshore oil activities.

5.3.2 Non-Compliance of Licences

With respect to operating within the geographical/seasonal or other timing restrictions of the licence, it has been suggested that the recording of positioning, timing and operating (e.g., use of suction pumps) information, be collected. Because of the cost of precise positioning equipment, this suggestion has yet to be carried out in the U.K. However, it is recommended that for improved management of the resource, improved position equipment be installed (see Section 3.5.2).

With the advances in electronics and satellite navigational systems such as the Global Positioning System (GPS), the possibility of having precise navigation with an overall accuracy of 10 m will be soon available and the cost of development of a "black box" recording device will not be prohibitive. In Canada, LORAN-C positioning would provide information on position within a ship's length (60 metres), with a total cost of receiver and data logger expected to be about $5,000 CDN. This equipment will allow precise monitoring by the authorities and allow the dredgers to conduct systematic extraction operations, which are more efficient and economic.

To ensure that most extraction operations are carried out within the terms of the licence or permit, appropriate forms, along with periodic (but unannounced) inspections should be done including inspection of the cargo, recording of quantities landed, and a review of ship's logs.

5.3.3 Unannounced Dredging

The problem associated with unannounced dredging activities is basically a lack of communication. While the Code of Practice (1981) (see Appendix 4) states that the fishing industry should be notified as to the areas to be worked by the dredging vessel, in practice (in the U.K.), this is not always carried out, in part because of the uncertainty in market demands for sand and gravel. Nevertheless, in Canada, a formal line of communication should be established between fishing industry organizations and the sand and gravel (or placer) industry. Part of this information exchange should include the Notice to Mariners (Coast Guard), and notification of fishing industry representatives. Since these recommendations would apply to prospecting licences, as well as during the production stage, for application in Canada, some modifications to the review procedures carried out in the U.K., are also recommended, which are discussed in Section 5.5.1.

5.3.4 Displacement of Fishing Industry

The biggest issue, and the one most difficult to resolve, is the displacement of local fishermen from favoured fishing grounds. During sand and gravel extraction, few adult fish are expected to be killed or injured. Instead, they are likely to vacate the area and it is believed that overall fish stocks would not be significantly affected. However, the fish may move to areas that are less accessible to fishermen, such as to deeper waters offshore, which cannot be fished by many of the smaller day vessels. Thus, while overall stocks may not be affected by sand and gravel extraction, the fishing potential of individual fishermen may be seriously impaired. Since it is also assumed that both industries have a right to their resource, it is essential that compromise solutions be sought.

The resolution would require site-by-site assessment and is dependent upon accurate resource information. From the fishing sector, frequency of use, percentage of total catch, seasonal patterns and alternative sites must be identified for each area under consideration for sand and gravel or mineral

extraction. Similarly, the dredging company must identify the quantity and quality of the resource, alternative sites and market requirements. Only when managers have access to these data can informed decisions be made as to whether or not a permit be granted and, if so, what conditions would be imposed.

It is recommended that detailed site-specific resource information, both from the fishing industry, as well as on sand and gravel reserves, be included with each application for an extraction licence.

In addition, more fundamental, long-term research is also required to add to the overall information base which, in turn, would improve the decision-making process. These aspects are discussed in further detail in Section 5.5.3.

5.4 FISHERIES RESOURCE, HABITAT AND OTHER ENVIRONMENTAL CONCERNS

Concerns related to the release of toxic substances, reduction of oxygen levels due to high organic content, or the deposition of fines were all considered to be minor with respect to sand and gravel extraction. They are primarily issues which have historically been associated with dredging harbours and navigation channels. Site-specific studies would ensure that potential problems are identified.

The main concerns are associated with (1) potential destruction of herring spawning grounds and sand eel beds; (2) potential damage to shellfish fishery, particularly lobsters and scallops; and (3) alteration of the seabed to the detriment of benthic organisms and fish species. While fines are generally not expected to be a problem during aggregate extraction, this may not be the case with placer mining and Section 5.6 discusses this issue.

5.4.1 Herring and Sand Eels

In the U.K., extraction is not permitted in known herring spawning areas or in regions where significant populations of sand eels (or sand lance) are present. The difficulty is in areas which may have high potential, but for which there is no information to support or refute the claim. In this regard, environmental studies carried out in concert with the assessment of the sand and gravel or mineral resource would provide critical information on which decisions could be based. Mitigative measures could include seasonal restrictions (e.g., avoid spawning period) or timing restrictions (e.g., dredge only during daylight hours when the sand eel is actively swimming).

5.4.2 Shellfish

Conflicts between shellfish harvesting and aggregate extraction in the U.K. have not occurred, although a recent application has generated some concern over the potential effects on crabs. In Canada, however, gravel areas may also include significant scallop and lobster resources (Scarratt, 1985).

It is essential, therefore, that before any marine sand and gravel operation begins, fishery resource information from the fishing industry, from fisheries personnel and/or from site-specific surveys, be obtained and reviewed.

5.4.3 Alteration of the Seabed

Alteration of the seabed, either by removal of surface material, leaving a substantially different substrate (e.g., clay, bedrock), or by changing the particle size composition by removing only selected portions of the seabed material, remains a widely debated issue, because of the uncertainty of the effects on future fish stocks. There is also a concern with the alteration of the topography, such as the deep pits which are left by anchor dredgers.

There is considerable uncertainty with respect to the effects on benthic organisms and on fish stocks, resulting from changes in sediment composition. It is argued that the scale of offshore sand and gravel extraction is small compared to the overall area available for the fishing industry, provided key or sensitive site are identified and avoided.

Complete removal of the mineral resource should be avoided and monitoring should be carried out to ensure that the substrate remains as similar as possible to its original state. It is desirable to have a periodic monitoring program which allows the resource managers and the dredging companies to properly manage the deposit. There are, however, two fundamental questions to be answered concerning this: (1) who does the monitoring? and (2) who pays for it? Unlike the hydrocarbons industry, the marine aggregate industry deals with a low cost, bulk material with low profit margins and large expenses for monitoring programs may either drive up the market price (unlikely) or make this industry uneconomical. There was some suggestion in the U.K. that the reasons why the Dutch or French marine aggregate industry have not been successful has been due to excessive costs in order to operate offshore. Monitoring is required and should be supported (in part) by Canadian research institutions.

More definitive answers on potential impacts require dedicated, long-term research programs. At present, only site-specific surveys are available to ensure that sensitive or biological habitats are identified.

This work should be supported by both government research institutions, to provide information on long-term processes and impacts, as well as the sand and gravel industry to monitor impacts caused by their operations.

5.5 ADMINISTRATION AND MANAGEMENT

Conflicts and concerns between the fishing industry and the sand and gravel industry in the U.K. can basically be traced to a lack of communication and information and an atmosphere of mistrust. Much of the problem is due to historical practices, when there was little regard for the fishing industry

by dredging vessels as they operated offshore. Neither the fishing industry nor the dredging industry appeared to understand the needs, concerns or constraints involved in their respective operations.

The Code of Practice (1981) was designed to improve communications and alleviate some of the uncertainty and mistrust each group has toward the actions of the others. Most of those involved accepted that it is a good first step, but that improvements are still required, primarily in accepting the "intent" of the Code, rather that the lack of any specific item.

Other administrative and management concerns expressed in the U.K. include licencing procedures and resource data bases.

5.5.1 Communication

In Canada, where there has not been a history of conflicts, development of lines of communication may greatly reduce potential problems. This would take place at a number of levels, as follows:

a) **During application for prospecting licence.** The fishing industry should have access to information on the operations of a dredging vessel. It is suggested that if the prospecting licence be made exclusive, there is no need for confidentiality on where the vessel will be operating (mineral resource information would remain proprietary) and communication between the fishing industry and the sand and gravel industry can be open. For the fishermen, they should be informed of where the vessel will be operating/prospecting, so that fishing gear can be retrieved or the area avoided. For the dredging companies, sensitive or productive habitats can be identified early on in the process, which should streamline any subsequent application for an extraction licence.

b) **During application of an extraction licence.** While the interests of fishing industry are considered in any government view through fisheries personnel, inclusion of fishing organizations would greatly improve communication between the fishing industry, government agencies and the sand and gravel companies.

c) **During production.** The sand and gravel industry should identify when and where the dredging vessels will be operating, in order that the fishermen have time to retrieve fishing gear or make alternative plans where to fish. It is suggested that a minimum of 48 hours notice of a vessel's operating schedule be given.

5.5.2 Licencing Procedures

In many ways, the licencing procedure for navigational dredging and offshore dumping permits in Canada is structurally similar to the review process in the U.K. Both procedures include a lead government agency to formulate a co-ordinated response, often by consulting all other departments which may have a vested interest in the proposed activity. In order to resolve some of the concerns expressed, especially by the fishing industry, some changes to the procedures practiced in the U.K. are suggested when considering regulations for Canada, including:

a) The final authority should be seen to be objective and not perceived to be overly influenced by the revenue side of the application;

b) There should be a mechanism for direct representation of the fishing industry in the regulatory process; and,

c) There should be a mechanism for appealing the decisions of the regulatory authority. (In other Canadian review and regulatory procedures such as the Ocean Dumping Act, appeals or administrative decisions can be made directly to the Minister responsible.)

5.5.3 Resource Information

One major concern which must be addressed by Canadian authorities, is the lack of information on both seabed material resources and on fishery resources. These data are essential for resource management personnel to enable them to make decisions on the suitability of sand and gravel or placer mine applications. Examples of the type of information required includes:

a) **Pre-Operational Site-Specific Information.** A number of baseline studies are recommended both prior to granting a licence, as well as during the life of the licence. The intent is to suggest studies that will provide sufficient information to determine whether there may be any significant environmental effects. The cost of data may be reduced if done simultaneously with prospecting and such information would greatly improve regulations with other users and assist in the regulatory review. Data collected and submitted as part of the application may include:

- thickness and lateral extent of mineral resource, including tonnage and specifications of material;
- presence of fines, organic or toxic materials;
- representative hydrological data (e.g., currents, wind or wave data);
- information on use of an area by commercial species for breeding - e.g., herring;
- presence of other commercial or important resources (e.g., scallops, lobsters, quahogs and other clams, sand lance);
- fishery information, including catch statistics, and frequency and timing of fishing activity.

b) **Operational Monitoring.** An operational monitoring program should focus on bathymetric changes and the quality and quantity (thickness and extent) of the deposit over time. The common methods used for these are using side-scan sonar, multi-frequency sounders, grab samples, cores and bottom photographs. Most of the normal surveying and prospecting equipment would be required to obtain the necessary information.

In general, bathymetric changes of less than 0.5 metres would be different to differentiate in the typical operating depths of 20 m and routine survey equipment. Nevertheless, periodic surveys should be carried out to (1) monitor bathymetric profiles and (2) re-assess the quantity of the reserve, with the overall objective of ensuring that the type of material remaining on the seabed is similar in composition to what was originally present, in order to minimize long-term environmental changes.

c) **Regional and/or Long-Term Studies.** There is also a need for more information on both the biological and geological resources. These data would relate to more long-term impacts and regional coverage, which extends beyond the boundaries of any single deposit, and which would provide information useful to managers of the resources. These studies are of a more general nature, warranting increased government involvement. These studies could include:

- accurate spatial mapping of seabed material, along with deposit thickness to improve estimates of the reserve. A particularly important component is the nearshore region, up to the 30-metre contour;
- fishery information, including sensitive productive areas for commercial or critical prey species;
- sensitivity of benthic species and fish to short-term and long-term extraction activities;
- recolonization rates of dredged areas and the sensitivity of benthic species to changes in particle size composition.

The most appropriate format for both the geological and biological resource information is map overlays, which can then be used for determining areas of conflict and alternative sites for development.

5.5.4 Compensation

In the U.K., compensation to fishermen is provided for gear damage from debris (e.g., screens) left on the bottom or by the dredging vessel itself. Compensation does not include loss of resource or livelihood claims. The claim is made by the fisherman to the dredging company responsible for the damage, or, if not satisfied with the company's response, to the Sand and Gravel Association who would then decide whether the compensation claim is valid.

A slightly different procedure is recommended for Canada, to eliminate the conflict of interest associated with the aggregate industry arbitrating claims against its members. A more neutral approach would be to establish an independent board whose members are selected or approved by both the fishing and the dredging industries.

The board would also review compensation claims where the responsible company cannot be identified.

As in all compensation claims, time is generally of the essence, and it is important for the process to proceed quickly. However, improved communications and good regulations could greatly reduce the need to appeal a compensation mechanism.

5.6 PLACER MINING

There is considerable potential for heavy mineral placers in Canada's offshore, especially for gold (Hale and McLaren, 1984; Pasho, 1985). Some of the concerns and issues related to placer mining are similar to those for aggregate dredging but require further study.

6.0 CONCLUSIONS

This report has reviewed the concerns and the regulatory process associated with the extraction of seabed resources (primarily sand and gravel) in the U.K., related to coastal erosion and conflicts with the fishing industry. The U.K. was selected as a reliable source of information on offshore sand and gravel extraction because of the long history of the industry in that country and because certain procedural and management practices have been instituted to deal with a variety of issues.

The report also reviews those issues which potentially could develop as sand and gravel operations expand in Canada and includes recommendations to reduce or mitigate the concerns.

The major issues which could develop in Canada were separated into four categories:

1. Coastal Erosion

a) changes in wave refraction;
b) removal of protective bars;
c) changes in sediment transport patterns; and,
d) changes in residual sediment types.

2. Impact on Fishing Operations

a) marine disposal of debris, especially screens;
b) vessels operating outside of the terms of their licence;
c) vessels arriving unannounced and interfering with fishing operations; and,
d) permanent or temporary displacement of local fishing industry by extraction operations.

3. Fishery Resource, Habitat and Other Environmental Concerns

a) potential destruction of spawning grounds and/or critical fish habitat;
b) alteration of the seabed to the detriment of subsequent recruitment of benthic organisms and fish species; and,
c) avoidance of sediment plumes by migrating species.

4. Administration and Management

a) lack of communication and information exchange between sand and gravel and fishing industries;
b) lack of procedures for the fishing industry to have direct input into the regulatory review process; and,
c) lack of basic information on both surficial geology and the biological and fishery resources.

It was concluded that because marine sand and gravel extraction operations are still in the beginning stages of development in Canada, there exists an opportunity to avoid some of the mistrust and lack of understanding which has developed in the U.K.

Structurally, the basic review procedure in the U.K. is similar to that carried out in Canada for ocean dumping permits, with a single government agency co-ordinating the input from all other agencies having a vested interest in the proposal. However, based on the U.K. experience, a number of changes for the Canadian review process procedure were recommended. These included:

a) appropriate environmental and geological resource data submitted with the application;
b) establishing a mechanism for fishing organizations and other non-government intervenors to be directly involved in the review process;
c) establishing lines of communication between the dredging companies and the fishing industry on prospecting and extraction activities and vessel movement;

d) issuing prospecting licences which are exclusive to one company in order to ensure that the fishing industry is informed of vessel movement; and,
e) monitoring of the licence area to record changes in bathymetry and bottom sediment characteristics;

A great number of the conflicts in the U.K. were related to a lack of information, particularly between the fishing and sand and gravel industries. If the lines of communication improved, it is believed that many of the concerns would be resolved.

The lack of detailed biological and geological resource information was identified as a major issue. Long-term studies on potential environmental impacts were also recommended. Provision of such data would allow resource managers to consider alternative sources for the sand and gravel industry, thus reducing potential environmental problems and conflicts with the fishing industry.

7.0 REFERENCES

Anon, 1969. Need for a clear-cut Government policy on dredging for aggregates. Hydrospace, Sept. Vol. 2, No. 3, p. 50-52.

Anon, 1972. The movement of offshore shingle. Worthing. Hydraulics Research Station, Report EX 591, Wallingford, Oxfordshire.

Anon, 1975. Aggregates: the way ahead. Report of the Advisory Committee on Aggregates, Department of Environment, England.

Anon, 1976. Guidelines for an environmental impact statement. Federal Environment Assessment Review Office, Canada.

Anon, 1979. OCS land minerals leasing for offshore mining of construction minerals in the Greater New York Metropolitan area: a feasibility survey. U.S. Dept. of Interior, PB81-192692.

Anon, 1981. A selected bibliography of dredging technology. World Dredging and Marine Construction, Oct.

Anon, 1982. Guidelines for aggregates provision in England and Wales, Joint circular report from Department of Environment and the Welsh Office, Circular 21/82, England.

Anon, 1983. Wave attenuation over uneven sea bed topography: A study of wave changes in relation to offshore dredging. Hydraulics Research Limited, Report EX 1143, Wallingford, Oxfordshire.

Anon, 1984. Sand and gravel mobility in relation to offshore dredging: A radioactive tracer study in the shipway channel off the Suffolk coast. Hydraulics Research Limited, Report EX 1176, Wallingford, Oxfordshire.

Archer, A.A., 1971. Economics of offshore exploration and production of solid minerals. Interregional Seminar on the Development of the Mineral Resources of the Continental Shelf.

Archer, A.A., 1974. Progress and prospects of marine mining. Mining Magazine, March, p. 150-163.

Arnold, G.T., 1985. Madeleine Island silica sand deposits. Presented at the 16th Underwater Mining Institute, Halifax.

Benckhuysen, C.G., 1980. Dredging in Canada is complex; diverse. World Dredging and Marine Construction, Nov., p. 18-20.

Bouma, A.H. (ed.), 1981. Shell dredging and its influence on the Gulf coast environment. Gulf Publ. Co., Houston, Texas, 454 pp.

Brampton, A.H., 1985. Effects of dredging on the coast. At Conference on Problems Associated with the Coastline, Newport, Isle of Wight.

Brossard, C., 1980. Organization and surveillance of a maritime dredging contract. In Third International Symposium on Dredging Technology, Bordeaux, BHRA Fluid Engineering, paper A1, p. 1-12 (in French).

Burton, J., 1981. Evaluation of the effects of hydraulic dredging on lobsters. Report for Les Mines Seleine Inc. by Montreal Ecological Research Centre.

Chase, G.L., 1976. Evaluation of environmental effects associated with sidecast dredging. In Offshore Technology Conference, Houston, pap. 2586, p. 621-634.

Cole, H.A., 1977. Sand and gravel extraction editorial. Source unknown. Vol. 8, No. 9, Sept. 77.

Cottell, D.S., 1978. Some international opportunities for marine aggregates. Oceanology International, p. 3-6.

Coughlan, T., 1985. Results of placer exploration activities on the inner-shelf off Country Harbour, Nova Scotia. Presented at the 16th Underwater Mining Institute Symposium, Halifax.

Cressard, A.P., 1981. Environment and site protection report, CNEXO, Oceanologic Centre of Brittany.

Cressard, A.P. and C.P. Augris, 1982a. French shelf sand and gravel regulations. In Offshore Technology Conference, Houston, pap. 4292, p. 717-724.

Cressard, A.P. and C. Augris, 1982b. Study of coastal erosion with the extraction of materials on the continental shelf. In Proc. IV Congress Int. Assoc. of Eng. Geology, Vol. VII New Delhi, p. 203-211.

Crickmore, M.J., C.B. Waters and W.A. Price, 1972. The measurements of offshore shingle movement. Proc. 13th Coastal Eng. Conf., A.S.C.E., Houston, p. 1005-1025.

Cruikshank, M.J. and H.D. Hess, 1975. Marine sand and gravel mining. Oceanus, 19 (1), p. 32-44.

Cuddy, C., 1985. Beaufort Sea sand and gravel inventory. Presented at the 16th Underwater Mining Institute Symposium, Halifax.

deGroot, S.J., 1979a. An assessment of the potential environmental impact of large-scale sand dredging for the building of artificial islands in the North Sea. Ocean Management (5) p. 211-232.

deGroot, S.J., 1979b. The potential environmental impact of marine gravel extraction in the North Sea. Ocean Management (5), p. 233-249.

deGroot, S.J., 1984. The impact of bottom trawling on benthic fauna of the North Sea. Ocean Management (9), p. 177-190.

deGroot, S.J., 1985. Report on specific terms of reference for a working group on the effects of sand and gravel extraction. ICES Report CM 1985/E:5, Marine Environmental Quality Committee.

Dickson, R. and Lee A., 1973. Gravel extraction effects on seabed topography. Offshore Services, Aug., p. 32.

Dickson, R.J., 1975. A review of current european research into the effects of offshore mining on fisheries, In Offshore Tech. Conf., pap. 2159, p. 103-118.

Engler, R.M., 1981. Impacts associated with the discharge of dredged material: management approaches, U.S. Army Engineers Waterways Experimental Laboratory. Vicksburg.

Envirocom Ltd., 1977. Isserk artificial island environmental baseline and monitoring study, 1977. Prepared for Imperial Oil Ltd., Calgary, 125 pp.

ESL, 1982. The biological effects of hydrocarbon exploration and production related activities, disturbances and wastes on marine flora and fauna of the Beaufort Sea region. Rept. for Dome Petroleum Ltd., Calgary.

Fowler, J. and C. Miller, 1985. The development potential for Nova Scotia's offshore aggregate and placer resources. Nova Scotia Department of Mines and Energy. Open File 656, 33 pp.

Gillie, R.D. and R.M. Kirk, 1979. Possible physical impacts from offshore sand and gravel mining: Northland, New Zealand. Report for Landsea Minerals Ltd., Whangarei, New Zealand.

Glasby, G.P., 1982. Marine mining and minerals research activities in Europe. Marine Mining, Vol. 3, No. 3-4, p. 379-409.

Goodie, J.L. and S. Soehle, 1971. Protecting the environment during Marine mining operations. Oceanology International, Nov., p. 25-27.

Hale, P.B. and P. MacLaren, 1984. A preliminary assessment of unconsolidated mineral resources in the Canadian offshore. Canadian Mining and Metallurgical Bulletin, Sept. 1984, 11 p.

Herbich, J.B. and Schiller, R.E., 1973. The environmental effects of dredging. United Nations, WODCON V, Hamburg, June, 20 p.

Herbich, J.B., and W.S. Greene, 1975. Bibliography on dredging. Volumes I and II. Center for Dredging Studies, Texas Engineering Experiment Station, Report No. CDS-179.

Hess, H.D., 1971 Marine sand and gravel mining industry of the United Kingdom. NOAA Tech. Report ERL 213-MMTC 1, U.S. Dept of Commerce.

Hess, H.D., 1972. Sand and gravel dredging reaches major proportions. World Dredging and Marine Construction, May, p. 15-18.

Hill, J.C.C., 1970. New legal arrangements needed for marine aggregate exploitation. Hydrospace, June.

Hughes, J.H., 1979. Effect of the environment on processing and handling materials at sea. R. Soc. Lond. Philos. Trans. Series A, V. 290, p. 161-177.

ICES, 1975. 1st Report of the Working Group on effects of fisheries of marine sand and gravel extraction. Co-operative Research Report No. 46.

ICES, 1977. 2nd Report of the Working Group on effects on fisheries of marine sand and gravel extraction. Co-operative Branch Report No. 64. No. CM 1977/E:68.

ICES, 1979. 3rd Report of the Working Group on effects on fisheries of marine sand and gravel extraction. Paper from the 3rd Meeting of the Working Group, No. CM 1979/E:3.

ICES, 1981. Bibliography on effects on fisheries of marine sand and gravel extration. No. CM 1981/E:5.

Jolliffe, I.P., 1974. Beach-Offshore Dredging: some environmental consequences. In Offshore Technology Conference, Houston, pap. 2056, p. 257-265.

Jones, A.R., 1986. The effects of dredging and spoil disposal on macrobenthos, Hawkesbury Estuary, S.W. Marine Pollution Bulletin, Vol. 17, No. 7, pp. 17-20.

Kelland, N.C., R.R. Dickson and D. Key, 1971. Research into effects of gravel dredging on fisheries and sediment movement. Hydrospace, March

Kidson, C. and A.P. Carr, 1959. The movement of shingle over the seabed close inshore. The Geographical Journal, 125, pp. 380-389.

Lee, G.F. et al., 1975. Research study for the development of dredged material disposal criteria. U.S. Army Engineer Waterways Experiment Station Report D-75-4.

Levings, C.D., 1982. The ecological consequences of dredging and dredge spoil disposal in Canadian waters. National Research Council, Pub. No. NRCC 18130.

MacLaren Plansearch. Review of disposal alternatives for dredged material, Vol. 2 technical review. Report for Public Works Canada and Transport Canada.

MAFF, 1981. Code of Practice for the extraction of Marine Aggregates.

Main, J. and G.I. Sangster, 1985. The behaviour of the Norway lobster (nephrops norvegicus (L.)), during trawling. Scottish Fisheries Research Report No. 34, report for Department of Agriculture and Fisheries for Scotland, 23 p.

Main, J. and G.I. Sangster, 1983. Fish reactions to trawl gear - a study comparing light and heavy ground gear. Scottish Fisheries Research Report No. 27. Report for Department of Agriculture and Fisheries for Scotland, 17 p.

Mason J. and J. Drinkwater, 1981. Experiments on suspended cultivation of mussels in Scotland. Scottish Fisheries Information Pamphlet No. 4, report for Department of Agriculture and Fisheries for Scotland, 15 p.

Miles, A.J., 1985. The marine sand and gravel industry of the United Kingdom. World Dredging, August, pp. 28-32.

Miller, J.N. et al., 1980. Physical, chemical and biological characteristics of deep water dredge spoil disposal. In Third Int. Symposium on Dredging Technology, Bordeaux, BHRA Fluid Engineering, paper G2, p. 389-401.

Miller, C., 1981. The marine mining potential of Nova Scotia for sand and gravel. Nova Scotia Dept of Mines, Open File Report 528, 34 p.

Milner, R.S. and R. Dickson, 1977. Physical and biological Studies of a dredging ground off the east coast of England. ICES Report CM 1977/E:48.

Motyka, J.M. and D.H. Willis, 1974. The effect of wave refraction over dredged holes. Proc. 14th Coastal Eng. Conference, A.S.C.E., Copenhagen, chp. 35, p. 615-625.

Myers, A., 1984. Current bibliography of offshore technology and offshore literature classification. Institute of Offshore Engineering, Aberdeen.

O'Connor, M., 1985. The occurrence of Beaufort sand and gravel: exploration and delineation. Presented at the 16th Underwater Mining Institute Symposium, Halifax.

Padan, J.W., 1977. New England offshore mining environmental study (Project NOMES). NOAA Special Report.

Pasho, D.W., 1985. Canada and Ocean Mining. Mar. Tech. Soc. J. 19:26-30.

Pasho, D.W., 1986. The United Kingdom aggregate industry; a review of management practices and issues, COGLA.

Pequegnat, W.E. and L.H. Pequegnat, 1980. Oceanographic surveys required for selection, official design and monitoring of dredged material dumpsites in the United States. In Proc. 3rd. Int. Sympos. Dredging Technology, BHRA Fluid Engineering, Bordeaux, pap. 63.

Price, W.A., J.M. Motyka, and L.J. Jaffrey, 1979. The effect of offshore dredging on coastlines. Hydraulics Research Station, Wallingford, Oxfordshire.

Rees, C.P., 1980. Environmental impact of dredging operations. In 3rd International Symposium on Dredging Technology, Bordeaux, BHRA Fluid Engineering, paper G1, p. 373-388.

Reinson, G.E. and D. Frobes, 1980. Effects of dredging activities on shoreline morphology and stability in northeastern New Brunswick. In Proc. Cdn. Coastal Conference, Burlington.

Rowland, T.J., 1985. Non-energy marine mineral resources of the world oceans. Mar. Tech. Soc. J. 19:6-17.

Roy, P. and C. Peat, 1971. Offshore dredging: literature survey and recommendations. Geological Survey of New South Wales, Department of Mines, New South Wales.

Scarratt, D.J., 1985. Fisheries interests and ocean mining. Presented at the Underwater Mining Institute, Halifax.

Shelton, R.G.J. and M.S. Rolfe, 1972. The biological implications of aggregate extraction: recent studies in the English Channel. ICES Report CM 1972/E:26.

Slaney, F.F. and Co. Ltd., 1977. 1976 summer aquatic studies Arnak L-30 artificial island site and Tuft Point burrow site. For Imperial Oil Ltd., Calgary.

Thomas, D.J., 1980. Water quality measurements and dredge spoil monitoring at McKinley Bay, N.W.T., 1980. For Dome Petroleum Ltd., Calgary, 41 pp.

Turner, M.T. and Fairweather, 1974. Dredging and the environment: the plus side. Civil Engineering, ASCE, Oct., p. 62.

Wallace, J.M., 1976. The control of wave action by configuration dredging at the entrance to Botany Bay, Sydney, Australia. Maritime Services Board of New South Wales, 10 pp.

Webb, P., 1979. Legal and economic aspects of dredging marine aggregates in the United Kingdom. World Dredging and Marine Construction, Nov., p. 34-38.

Yalin, M.S., 1977. Mechanics of Sediment Transport. Pergamon Press, Toronto, 298 p.

APPENDIX 1

LIST OF DREDGERS IN THE U.K., 1985

Appendix 1. List of Dredgers in the U.K., 1985

COMPANY AND VESSELS		GRT (tonnes)	DWT (tonnes)	LENGTH (m)	BEAM (m)	DRAFT (m)	CARGO (tonnes) (s=self discharge)	SPEED (kts)	TYPE (T=Trailer) (A=Anchor)	OPERATION AREA
ARC Marine										
ARCO SCHELDT	1972	1583	2844	76.5	14.3	4.9	2160 S	12.5	T	S.COAST,FOREIGN
ARCO SEVERN	1974	1599	2806	81.5	14.1	5.0	2250 S	12.0	T	S.COAST,FOREIGN
ARCO TAMAR	1964	355	508	47.6	8.8	2.8	383	10.0	A	BRISTOL CHANNEL
ARCO TAW	1968	349	508	47.6	8.8	2.8	383	10.0	A	BRISTOL CHANNEL
ARCO TEST	1971	594	812	63.6	9.9	3.3	738	10.5	T	LAID UP
ARCO THAMES	1974	2645	4357	98.5	15.5	5.4	3492 S	12.0	T	NORTH SEA,FOREIGN
ARCO TRENT	1971	594	812	63.6	9.9	3.3	738	10.5	T	S.COAST,S.NORTH SEA
ARCO TYNE	1975	2684	4357	98.5	15.5	5.4	3600 S	13.0	T	NORTH SEA,FOREIGN
DEEPSTONE	1972	5487	8962	107.0	20.1	7.4	7506 S	14.0	T	NORTH SEA,S.COAST
MARINESTONE	1972	2206	3257	84.0	6.8	5.5	2186 S	12.0	T	NORTH SEA,S.COAST
NABSTONE	1970	1579	2928	80.6	14.3	5.1	2160 S	12.0	T	NORTH SEA,S.COAST
NEW VESSEL	1986	----	5350	93.0	17.4	7.9	- S	12.0	T	-
BOWEN & CAINES LTD.										
SOLENT LEE	1959	757	1129	62.0	9.4	3.8	945	10.0	T	S.COAST

Appendix 1 (cont'd)

COMPANY AND VESSELS		GRT (tonnes)	DWT (tonnes)	LENGTH (m)	BEAM (m)	DRAFT (m)	CARGO (tonnes) (s=self discharge)	SPEED (knts)	TYPE (T=Trailer) (A=Anchor)	OPERATION AREA
BRITISH DREDGING PLC										
BOWQUEEN	1963	1238	1577	78.5	12.2	4.6	1512	12.5	A	BRISTOL CHANNEL
BOWCROSS	1967	487	968	59.8	12.0	4.3	1260	10.0	A	BRISTOL CHANNEL
PETERSON	1961	748	894	53.6	10.2	3.9	864	9.0	A	BRISTOL CHANNEL
CIVIL AND MARINE LTD.										
CAMBOURNE	1980	3122	4557	97.5	17.1	6.3	4680 S	12.0	T	S.NORTH SEA, S.COAST, FOREIGN
CAMBRAE	1973	3896	5202	101.6	17.1	6.4	5400 S	12.5	T	S.NORTH SEA, S.COAST
HOLMS SAND AND GRAVEL CO.										
HARRY BROWN	1962	634	950	52.3	9.8	4.1	810	9.5	A	BRISTOL CHANNEL
NORLEADER	1967	1560	2250	78.1	13.8	4.7	2171 S	12.0	A	LAID UP
KENDALL BROS.										
KAIBEYAR	1955	671	1006	54.8	11.2	3.7	864	9.0	T	S.COAST
KB	1948	299	438	42.0	7.4	2.9	432	8.5	T	S.COAST
NORTHWOOD (FAREHAM) LTD.										
AFAN	1961	1000	1152	60.8	11.6	4.3	1188	10.0	T	S.COAST
COAST FARMER	1955	313	468	44.2	8.8	2.6	275	5.5	A	S.COAST
GLEN GOWER	1963	552	605	51.7	9.2	3.7	630	10.0	T	S.COAST
HEXHAMSHIRE LASS	1955	561	782	48.1	10.1	3.6	684	10.5	T	S.COAST
STEEL WELDER	1955	500	595	52.1	9.1	3.2	504	8.5	T	S.COAST

Appendix 1 (cont'd)

COMPANY AND VESSELS		GRT (tonnes)	DWT (tonnes)	LENGTH (m)	BEAM (m)	DRAFT (m)	CARGO (tonnes) (s=self discharge)	SPEED (knts)	TYPE (T=Trailer) (A=Anchor)	OPERATION AREA
NORWEST SAND AND BALLAST CO.										
NORSTAR	1961	613	1117	47.6	11.0	4.2	850	9.0	A	IRISH SEA
RMC										
BOWBELLE (F)	1964	1475	1880	79.9	13.6	4.2	1728	11.7	T	LAID UP
BOWHERALD	1974	2965	4425	95.6	18.2	5.1	3742 S	13.5	T	LAID UP
BOWKNIGHT	1974	2965	4425	99.1	18.2	5.1	3742 S	13.5	T	NORTH SEA,FOREIGN
BOWPRINCE	1964	1485	2083	80.7	13.8	4.5	1836	12.2	T	LAID UP
BOWSPRITE (F)	1967	1503	2093	80.5	14.0	4.3	1681	12.2	T	NORTH SEA,FOREIGN
BOWSTREAM	1971	1555	2438	82.6	13.0	4.7	1847 S	12.5	T	NORTH SEA
BOWTRADER (F)	1969	1592	2636	86.2	14.7	4.2	2160	12.0	A	NORTH SEA
RHONE	1966	161	280	45.5	8.7	2.5	252	8.0	A	BRISTOL CHANNEL
SAND GULL	1964	534	728	53.0	9.3	3.5	664	9.5	T	S.COAST
SAND LARK	1963	540	715	53.1	9.3	3.5	664	9.5	T	LAID UP
SAND SERIN	1974	1219	2120	66.6	12.2	4.8	1501	10.5	T	S.NORTH SEA
SAND SWAN	1970	1164	1944	66.6	12.5	4.4	1530	10.0	A	S.COAST,S.NORTH SEA,FOREIGN
SAND SWIFT	1969	1162	1944	66.5	12.5	4.3	1584	10.2	A	S.COAST,S.NORTH SEA,FOREIGN
SAND TERN	1964	535	717	53.0	9.3	3.5	604	9.5	T	S.COAST,BRISTOL CHANNEL
SAND WADER	1971	3085	5209	96.5	17.0	6.2	3960 S	11.5	T	S.NORTH SEA,S.COAST FOREIGN
SAND WEAVER	1975	3366	5271	96.4	16.7	6.1	3960 S	12.0	T	S.NORTH SEA,S.COAST FOREIGN

Appendix 1 (cont'd)

COMPANY AND VESSELS		GRT (tonnes)	DWT (tonnes)	LENGTH (m)	BEAM (m)	DRAFT (m)	CARGO (tonnes) (s=self discharge)	SPEED (knts)	TYPE (T=Trailer) (A=Anchor)	OPERATION AREA
SAND SUPPLIES (WESTERN) LTD.										
SAND DIAMOND	1973	770	1534	60.8	9.5	4.3	1260	10.0	A	BRISTOL CHANNEL
SAND SAPPHIRE	1963	772	1024	61.9	9.8	3.8	720	11.0	A	BRISTOL CHANNEL
TARMAC										
CHICHESTER CITY	1970	991	1726	59.8	12.0	4.4	1386	10.0	A	S.COAST
CHICHESTER STAR	1973	968	1708	59.8	12.0	4.4	1411	10.0	A	S.COAST
GLEN HAFOD	1960	552	605	51.7	9.2	3.7	612	10.0	A	LAID UP
HOVERINGHAM I	1966	897	1268	62.2	11.3	3.8	990 S	10.0	A	IRISH SEA, BRISTOL CHANNEL, S.COAST
HOVERINGHAM IV	1969	1027	1591	72.0	12.1	3.8	1125 S	11.0	A	ALL AREAS
HOVERINGHAM V	1969	1027	1591	72.0	12.1	3.8	1125 S	11.0	A	IRISH SEA, BRISTOL CHANNEL, S.COAST
HOVERINGHAM VI	1971	1551	2800	80.5	14.1	5.0	2340 S	10.5	T	NORTH SEA

APPENDIX 2

SAND AND GRAVEL EXTRACTED FOR AGGREGATES, FILL AND EXPORTS FROM THE U.K., 1965 TO 1984

Appendix 2. Sand and Gravel Extracted for Aggregates, Fill and Exports from the U.K., 1965 to 1984.

YEAR	QUANTITY (tonnes)
1965	7,176,796
1966	7,225,994
1967	8,434,339
1968	11,701,088
1969	12,631,871
1970	12,840,620
1971	13,140,341
1972	16,782,987
1973	21,205,773
1974	18,764,894
1975	20,241,173
1976	16,436,512
1977	15,108,991
1978	15,863,847
1979	18,306,556
1980	17,798,716
1981	15,916,137
1982	16,623,888
1983	16,585,920
1984	16,680,133

Note: It is not known what is the total allowable maximum annual tonnage value.

APPENDIX 3

CODE OF PRACTICE, 1977: CEC AND SAGA (MARINE SECTION)

CROWN ESTATE DREDGING LICENCES

Code of Practice agreed between Crown Estate Commissioners and Marine Section of Sand & Gravel Association – March 1977.

1. An application for a production licence will be considered only if the applicant has first held a prospecting licence covering the area in question and has submitted full and proper prospecting details to the satisfaction of the Civil Engineer (Marine Survey) at the Crown Estate Office.

2. Production licences will be on an annual basis determinable by either side at any time on 6 months notice. They will not be expressed to give the licensee the exclusive right to dredge over the licensed area but wherever practicable and reasonable the Commissioners will normally arrange that only one licence is granted for any one area.

3. The retention of the power to determine on 6 months notice is regarded as essential to provide assurance for other interests, especially those concerned with coast protection and fishing, that a licence is capable of being brought to an end at reasonably short notice if the dredging, against expectation is eventually shown to be so harmful to such interests as to require its cessation. Also this provision enables the Commissioners to take effective and speedy action against operators who fail to comply with the terms of their licences or who may not exercise proper control or supervision over the activities of their dredgers. The only other foreseeable circumstances in which the Commissioners might wish to exercise the power of determination would be:–

(a) To eliminate licences which had not been used for long periods (say in excess of 3 years) although the Commissioners would have regard to a company's overall performance and its needs for reserves for future use.

(b) In the event of a company being put in the hands of a receiver or going into liquidation.

(c) To provide for a review of royalty rates. In this case the notice of determination would be accompanied by the offer of a new licence at the revised rates.

4. Although the Commissioners will review royalty rates for each area after the expiry of two years from the date the current rate was introduced, any general increase in royalty rate for an area will not take effect before 3 years from the date of introduction of the existing current rate. To give effect to any increased royalty rate existing licences will either require to be determined in order that new licences can be offered to existing operators at the revised rates or supplemental deeds under seal recording the revised rates will need to be completed. The intention is to give operators at least 9 months notice of the intention to amend royalty rates.

5. Any completely new licences in an area will be granted at a royalty rate, to be assessed at the time, which will not necessarily be at the same royalty rate as that currently in force for the area.

6. If upon a general review a change is proposed to be made to the royalty rate for an area, the Civil Engineer (Marine Survey) will discuss his proposals with representatives of the licensees concerned and will take note of any representations which they might wish to make. These representations will be reported to the Commissioners for their consideration with the intention that an agreed royalty rate would be arrived at. This procedure will be conducted upon an area basis and will not be written into individual licences.

7. In the event of the Commissioners receiving complaints or otherwise becoming aware of the possibility that an operator had carried out unauthorised dredging outside his licensed area; or has infringed the terms of a licence relating to a licensed area, the complaint with all information relating thereto will as soon as possible be referred to the operator concerned with a request for full details of the alleged incident or incidents together with any explanation the operator wishes to furnish. In the light of the information provided by the complainant and the operator, together with any other information which the Commissioners may obtain from other sources, they will decide whether the complaint or infringement has been proved to their satisfaction and what, if any, penalty should be imposed upon the Company concerned. The operator will be advised of the decision and will be given the opportunity to make any further representations before it is implemented.

8. Licence areas will be defined on Admiralty charts and by the notation of appropriate co-ordinates.

9. Licences will be granted only to companies which have the necessary vessels, facilities and resources to dredge material themselves. In the event of a company stripping itself of the majority of its assets other than the Crown licence, the licence will be terminated.

10. Licences are not assignable. Where one company is acquired by another but all its assets including the licence continue to be used by the original company no problem about transfer of the licence will arise. If the acquiring company subsequently wishes the licence to be in its own name this can be achieved by the formal surrender of the old licence and the grant of a new one to the new company. If a company were to sell off its dredging assets, including vessels, wharves, treatment plants, etc. as an entire unit, the Commissioners would be prepared to give consideration to re-issuing the dredging licences held in connection with such assets to the purchasing company provided the selling company formally terminated the licences. In reaching a decision the Commissioners would look at the whole transaction to ensure that the licences were in proportion to other dredging assets being disposed of and that the purchasing company was either already a Crown licensee or if not was acceptable as a dredging operator.

11. Dead Rents are due and payable on the dates specified in the licence and are not related to any period. However if a licence is terminated other than on the anniversary of the commencing date for reasons other than default by the operator, a refund of the proportionate part of any dead rent not already merged into royalties may be made. Provisions to this effect will be included in the individual licence and refunds will be made only where licences contain such provisions. As far as possible, all licences will provide for the payment of dead rents and royalties on 1 January and 1 July in each year.

12. Operators will be responsible for obtaining all necessary statutory consents.

APPENDIX 4

CODE OF PRACTICE, 1981: MAFF AND SAGA (MARINE SECTION)

CODE OF PRACTICE FOR THE EXTRACTION OF MARINE AGGREGATES

INTRODUCTION

1.1 The purpose of this Code of Practice is to provide a basis for close liaison at working level between the fishing and dredging industries in order to promote mutual cooperation and to reduce to a minimum potential interference with each other's activities and damage to each other's resources. It is a voluntary Code which will only be effective if it receives the active support of those directly involved.

1.2 The Code is essentially aimed at establishing practical working communications at local level. Marine extraction is necessary from the national point of view and there will be a need to consider the grant of new dredging licences in areas where there is commercial fishing in order to meet the existing and foreseeable demands for marine aggregates. The object of the Code, therefore, is to assist the development of working relationships between the fishing and dredging industries which minimise interference with fishing while facilitating dredging operations. Modern extraction methods have come a long way from earlier practices and, when properly applied, have a minimum of effect on the seabed.

1.3 It should be emphasised that the establishment of the Code will not affect the formal Government consultation arrangements which are described in the Appendix prepared by the Ministry of Agriculture, Fisheries and Food (MAFF) in consultation with the Department of the Environment (DOE) and the Crown Estate Commissioners (CEC). The Marine Section of the Sand and Gravel Association (SAGA) will continue to have direct access to DOE and CEC on all matters concerning the winning of marine aggregates; liaison with the appropriate fishermen's organisations at national level will continue to be the responsibility of MAFF HQ, which will keep the organisations informed about applications for extraction licences, bulk sampling proposals and prospecting and extraction licences issued for England and Wales.

1.4 The development of liaison between the two industries at working level requires, so far as the fishing industry is concerned, an organised regional network which can offer the dredging companies clear-cut points of contact. In England and Wales, the Association of Sea Fisheries Committees has agreed that this task should be undertaken by Sea Fisheries Committees (SFCs). The Association and the members of the Marine Section of SAGA have undertaken to introduce the procedures set out in the Code on 1 January 1982.

1.5 Most dredging activity takes place off the English and Welsh coasts. However, clear lines of communication are also necessary for operations in Scottish waters. In the absence of SFCs in Scotland, the Department of Agriculture and Fisheries for Scotland (DAFS) will supply individual dredging companies with details of appropriate local contact points for the fishing industry. DAFS will also be responsible for liaising with national fishing organisations. For reasons of clarity the Code contains a separate section for Scotland but the procedures themselves will be essentially the same as those applying to England and Wales.

CODE OF PRACTICE FOR ENGLAND AND WALES

I: PROSPECTING

2.1 The CEC will inform MAFF HQ in confidence when they intend to grant a prospecting licence, with the name of an appropriate company contact.

2.2 MAFF HQ will consult its Fisheries Research Laboratory at Burnham-on-Crouch and the District Inspector of Fisheries, but no outside interests.

2.3 Based on advice from Burnham and the District Inspector, MAFF HQ will notify the CEC (with a copy to the company) of any readily identifiable areas where there might be objections to subsequent extraction. This will be for information only.

2.4 When a prospecting licence is issued, the CEC will inform MAFF HQ, which will send details to Burnham, the District Inspector and SFC. MAFF HQ will provide the company (with a copy to the CEC) with the names and addresses of the District Inspector and SFC (in some cases more than one District Inspector and SFC will be involved).

2.5 Before prospecting starts the company will approach the SFC to discuss working contacts. The SFC will invite the company to provide information on its proposed operations, will supply the company with information about local fishing activity and will discuss any potential difficulties.

2.6 The SFC will inform local fishermen of the issue of a licence and of the company's proposed work schedule and will act as the contact point for any further queries fishermen may have.

2.7 The CEC will inform MAFF HQ of any proposal to take samples by dredging, including the planned area, time and method of working.

2.8 MAFF HQ will inform Burnham, the District Inspector and SFC. If the proposals as they stand would involve a significant risk to fisheries resources MAFF HQ will notify the CEC (with a copy to the company). Such objections will be discussed informally with the company on request.

2.9 If MAFF HQ is satisfied that the proposed operation poses no substantial risk to fisheries resources it will inform the CEC (with a copy to the company), the District Inspector and SFC.

2.10 The SFC will inform local fishermen as appropriate.

II: EXTRACTION

2.11 Under the Government View procedure DOE will consult MAFF HQ on an application for an extraction licence. MAFF HQ will consult Burnham and the District Inspector. This is an inter-Departmental procedure and does not represent a basis for public consultation.

2.12 Unlike prospecting applications, extraction applications are not subject to commercial confidentiality once they have been notified through the Government View procedure. MAFF HQ will therefore also inform the SFC, which will have the opportunity to put views to MAFF HQ.

2.13 MAFF HQ will formulate a Departmental view. If MAFF HQ has in mind to object it will first notify the company informally, through the CEC, giving the reasons. Where possible MAFF HQ and the company will attempt to resolve the objections, involving the SFC where appropriate.

2.14 MAFF HQ will then put its formal comments to DOE under the Government View procedure.

2.15 When an extraction licence is issued, the CEC will inform MAFF HQ, which will send details to Burnham, the District Inspector and SFC. The SFC will inform local fishermen. Wherever possible the working methods listed in Annex A will be used.

III: TIMETABLE

2.16 The timetable for the consultations set out in this Code is at Annex B.

ANNEX A

Code of Practice for England and Wales

WORKING METHODS TO BE USED BY THE DREDGING INDUSTRY WHEREVER POSSIBLE

In response to paragraph 1.2 of the Code of Practice, the dredging and fishing industries will take all reasonable steps to ensure that their activities cause the minimum of interference or damage to each other. In particular, the dredging industry will:-

(a) provide the District Inspector and SFC with as much advance notice as possible of the areas to be worked;

(b) inform the District Inspector and SFC of any areas not being worked for the time being;

(c) work each licensed area in as systematic a manner as is practicable, giving advance information to the District Inspector and SFC of any changes in plan;

(d) wherever possible, work up and down the tidal streams.

ANNEX B

Code of Practice for England and Wales

TIMETABLE FOR CONSULTATIONS

(NB. These are maximum periods and consultations should be completed sooner wherever possible.)

Notification to MAFF HQ of intention to issue prospecting licence

2 weeks to comment to CEC

Notification to MAFF HQ of issue of prospecting licence

1 week to notify Burnham, District Inspector and SFC

1 week to agree working contacts and arrange meeting if needed

Notification to MAFF HQ of proposal to take samples by dredging

1 week to notify Burnham, District Inspector and SFC

3 weeks to comment to CEC

Government View procedure

1 week to notify Burnham, District Inspector and SFC

4 weeks to comment to MAFF HQ

2 weeks to formulate MAFF view, arrange meeting with company if necessary, and send final view to DOE

CODE OF PRACTICE FOR SCOTLAND

I: PROSPECTING

3.1 The CEC will inform DAFS HQ in confidence when they intend to grant a prospecting licence, with the name of an appropriate company contact.

3.2 DAFS HQ will consult its Marine Laboratory at Aberdeen, the Sea Fisheries Inspectorate and Inspector of Salmon and Freshwater Fisheries, but no outside interests.

3.3 Based on advice from Aberdeen and the Inspectorate, DAFS HQ will notify the CEC (with a copy to the company) of any readily identifiable areas where there might be objections to subsequent extraction. This will be for information only.

3.4 When a prospecting licence is issued, the CEC will inform DAFS HQ, which will send details to Aberdeen, the Inspectorate and the appropriate fishing organisation or organisations. DAFS HQ will provide the company (with a copy to the CEC) with the names and addresses of the Area Inspector and fishing organisations.

3.5 Before prospecting starts the company will approach the appropriate fishing organisations to discuss working contacts. The organisations will invite the company to provide information on its proposed operations, will supply the company with information about local fishing activity and will discuss any potential difficulties.

3.6 The fishing organisations will inform their local members of the issue of a licence and of the company's proposed work schedule and will act as the contact point for any further queries fishermen may have.

3.7 The CEC will inform DAFS HQ of any proposal to take samples by dredging, including the planned area, time and method of working.

3.8 DAFS HQ will inform Aberdeen, the Inspectorate and appropriate fishing organisations. If the proposals as they stand would involve a significant risk to fisheries resources DAFS HQ will notify the CEC (with a copy to the company). Such objections will be discussed informally with the company on request.

3.9 If DAFS HQ is satisfied that the proposed operation poses no substantial risk to fisheries resources it will inform the CEC (with a copy to the company), the Inspectorate and appropriate fishing organisations.

3.10 The fishing organisations will inform their members as appropriate.

II: EXTRACTION

3.11 Under the Government View procedure DOE will consult DAFS HQ on an application for an extraction licence. DAFS HQ will consult Aberdeen and the Inspectorate. This is an inter-Departmental procedure and does not represent a basis for public consultation.

3.12 Unlike prospecting applications, extraction applications are not subject to commercial confidentiality once they have been notified through the Government View procedure. DAFS HQ will therefore also inform the appropriate fishing organisations, which will have the opportunity to put views to DAFS HQ.

3.13 DAFS HQ will formulate a Departmental view. If DAFS HQ has in mind to object it will first notify the company informally, through the CEC, giving the reasons. Where possible DAFS HQ and the company will attempt to resolve the objections, involving fishing organisations where appropriate.

3.14 DAFS HQ will then put its formal comments to DOE under the Government View procedure.

3.15 When an extraction licence is issued, the CEC will inform DAFS HQ, which will send details to Aberdeen, the Inspectorate and appropriate fishing organisations. The fishing organisations will inform their members. Wherever possible the working methods listed in Annex A will be used.

III: TIMETABLE

3.16 The timetable for the consultations set out in this Code is at Annex B.

ANNEX A

Code of Practice for Scotland

WORKING METHODS TO BE USED BY THE DREDGING INDUSTRY WHEREVER POSSIBLE

In response to paragraph 1.2 of the Code of Practice, the dredging and fishing industries will take all reasonable steps to ensure that their activities cause the minimum of interference or damage to each other. In particular, the dredging industry will:-

(a) provide the Area Inspector and fishing organisations with as much advance notice as possible of the areas to be worked;

(b) inform the Area Inspector and fishing organisations of any areas not being worked for the time being;

(c) work each licensed area in as systematic a manner as is practicable, giving advance information to the Area Inspector and fishing organisations of any changes in plan;

(d) wherever possible, work up and down the tidal streams.

ANNEX B

Code of Practice for Scotland

TIMETABLE FOR CONSULTATIONS

(NB. These are maximum periods and consultations should be completed sooner wherever possible.)

Notification to DAFS HQ of intention to issue prospecting licence

2 weeks to comment to CEC

Notification to DAFS HQ of issue of prospecting licence

1 week to notify Aberdeen, Inspectorate and fishing organisations

1 week to agree working contacts and arrange meeting if needed

Notification to DAFS HQ of proposal to take samples by dredging

1 week to notify Aberdeen, Inspectorate and fishing organisations

3 weeks to comment to CEC

Government View procedure

1 week to notify Aberdeen, Inspectorate and fishing organisations

4 weeks to comment to DAFS HQ

2 weeks to formulate DAFS views, arrange meeting with company if necessary, and send final view to DOE

APPENDIX

PROCEDURES FOR LICENSING PROSPECTING AND EXTRACTION OF MARINE AGGREGATES

Introduction

1. Most mineral rights in UK waters are vested in the Crown and companies cannot prospect for, or extract, marine aggregates without a licence from the CEC. In addition, under Section 34 of the Coast Protection Act 1949 operations at sea which may interfere with navigation require the consent of the Secretary of State for Trade. This Appendix describes the formal inter-Departmental consultation arrangements which apply to the issue of prospecting and extraction licences; for convenience it refers only to the arrangements as they relate to MAFF, but DAFS apply very similar procedures in respect of Scottish waters.

Prospecting licences

2. Modern prospecting operations, properly conducted, cause little disturbance to the marine environment or interference with other activities at sea. There is therefore no formal Government consultation procedure and MAFF cannot and does not object to the grant of prospecting licences. The CEC do, however, inform MAFF before issuing any prospecting licence. Having consulted Burnham and the District Inspector, MAFF informs the company concerned of any readily identifiable areas where there may be fisheries objections to subsequent extraction operations. This advice does not prevent the company prospecting in those areas, nor does it automatically imply that there would be no objection to later extraction in other areas. Until they are issued, prospecting licences are regarded as commercially in confidence and MAFF does not consult organisations outside the Ministry. Once a licence has been granted MAFF will provide details to the SFC and the appropriate national fishermen's organisations.

3. Commercial dredgers are commonly used for prospecting operations; however, any bulk sampling must be separately authorised by the CEC, who have agreed to consult MAFF in advance. In the light of advice from Burnham and the District Inspector, MAFF may propose any modifications which it considers necessary to protect important fisheries resources (eg to the time or place of the operation or the method of extraction). Such modifications would be solely concerned with the likely effect of the sampling operation. MAFF would not object to sampling simply on the grounds that there would be objections to full-scale extraction later, although the company would be alerted if there clearly would be such objections. Under the arrangements proposed in the Code there would also be local consultation to ensure that bulk sampling operations did not interfere unnecessarily with fishing activity or fixed gear.

Extraction licences

4. Applications for extraction licences are subject to formal inter-Departmental consultation under what is generally known as the Government View procedure. This is coordinated by DOE, which consults all interested Departments including MAFF. MAFF comments are invariably based on advice from Burnham and the appropriate District Inspector. In addition, the CEC have now agreed that outside interests may be consulted at this stage. If MAFF expects to object to a proposal it will offer the company concerned an opportunity to resolve difficulties through informal discussions before putting comments to DOE. DOE, having considered comments from all Departments, puts a formal Government View to the CEC.

5. The Government View procedure is designed to provide a mechanism for considering licence applications and, if necessary, resolving substantial objections to them wherever possible. Both the fishing and extraction industries are legitimately exploiting the sea's resources; no one industry or activity can have an absolute priority and MAFF does not oppose extraction licences simply on the grounds that the area is fished commercially. Objections are limited to those cases where extraction could seriously damage fisheries resources or interfere to an unacceptable extent with an important commercial fishery.